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THE ROTARY CONVERTER

(A Complete Test as Synchronous Motor, Rotary Converter and Inverted Rotary.

(By Edward B. Lester.)

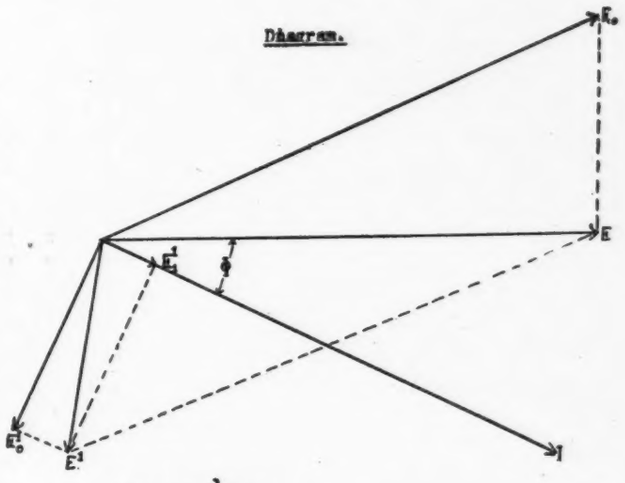
The rotary converter, having both commutator and ring attachments, is very flexible in the uses to which it can be put, for it may be run as a direct current or alternating current generator, direct current motor or alternating current synchronous motor, rotary converter or inverted rotary. The following article treats of the rotary converter machine used as a synchronous motor, rotary converter and inverted rotary, and is illustrated by plots of tests upon a 250 volt, 120 ampere, 30 kilowatt, 60 cycle, 600 revolution per minute, 2-phase machine built by the Excelsior Electric Co., New York.

Three methods of starting the machine were used. The first is that commonly in use where provision for it has been made. A direct current motor or induction motor is belted to the machine, by which it is brought up to speed. A motor of about one-tenth the capacity of the machine is required to do this. A second method of starting is by direct connection of the machine to the source of alternating current supply, the field circuit being open, when the machine starts as a hysteresis motor. This method is slightly dangerous, as a high E. M. F. is likely to be induced in the field circuit, and for this reason the field circuit should be opened in more than one place. The third method of starting was the most convenient in these tests. The machine was started as a direct current motor and synchronized by means of synchronizing lamps; at the right moment the direct current source was removed and the switch connecting to the source of alternating current supply was closed.

Plate 1 shows, in three figures, the general scheme of connections as (Fig. 1) synchronous motor, (Fig. 2) alternating synchronous motor and rotary converter, and (Fig. 3) inverted rotary. The machine was first treated as a synchronous motor. In any synchronous motor an analysis of the E. M. F. relations may be made as follows:

Let E =Terminal voltage, assumed as zero vector
I =Motor current, at angle plus ϕ for lagging current or — ϕ for leading current
E^1_1=Voltage consumed by resistance=Ir.
E^1_0= " " " synchronous reactance = Ix_0
$\overline{E}^1 = \overline{E}^1_1$ plus $\overline{E}^1_0$=Voltage consumed by synchronous impedance
E_0 =Counter E. M. F. of motor, or nominal induced E. M. F.
Then $\overline{E} = \overline{E}^1$ plus $\overline{E}_0$
Let p=cos ϕ and q = sin ϕ

In the diagram we will consider conditions for ϕ negative and leading current.



Then $E = E^1 + E_0$

$= E_0 + (E^1_1 + E^1_0)$

$E_0 = \sqrt{(Ep - Ir)^2 + (Eq - Ix_0)^2}$

Whence $E = I(rp + x_0 q) \pm \sqrt{Eo^2 - I^2(x_0 p - rq)^2}$

Fig. 4, the armature current and the power factor plotted as ordinate with fractions of full load as abcissae.

In considering change of mechanical load, or power P, we know that $P = EI \cos \phi$ As the voltage is usually constant, or nearly so, this change of load must come about by change of current, or change of phase relations, or both. Fig. 4 shows that both change, even though there is no change of speed nor change of field. The active pressure E_0 which sends current through the armature, is the vectorial difference of the counter E. M. F., E_0, and the impressed or terminal voltage E. This pressure E^1 varies because of change of phase of the impressed or terminal voltage E in its relation to the counter voltage Eo. These two voltages may remain exactly constant in value, and a change, as an increase in load, will cause the armature to fall back in phase to a greater angle of lag, and the counter E_0 lags to an equal extent behind the impressed E, giving a greater vectorial difference E^1 to produce current. It is chiefly the change of relative phase of the voltages that produces change of currents.

A difference of wave form of generator and motor produces two effects, a tendency to hunt, so that the waves of

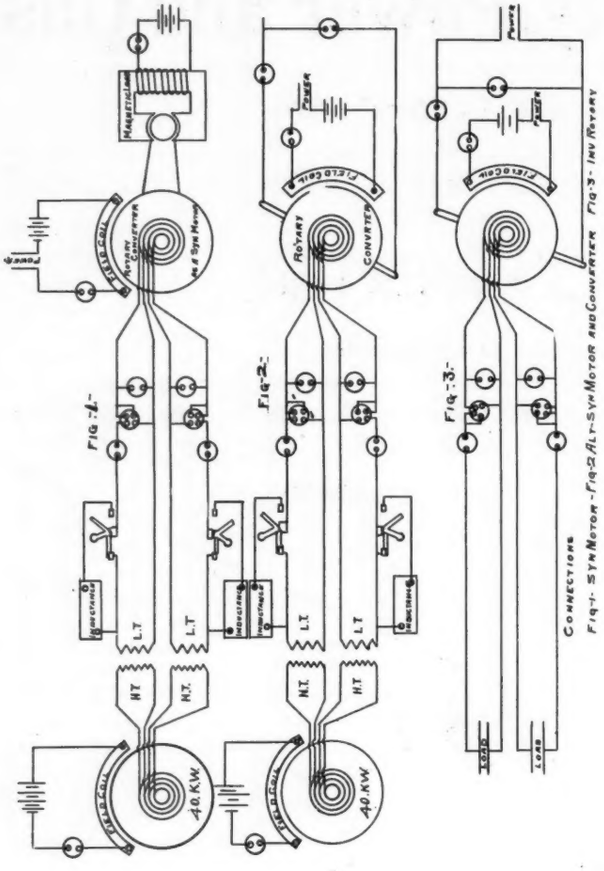
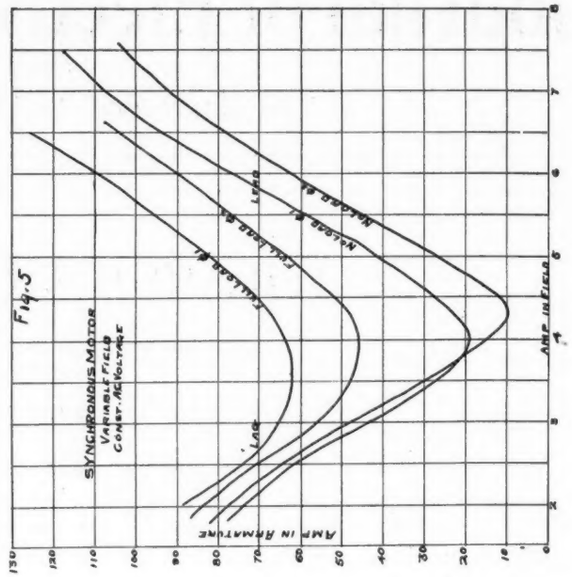
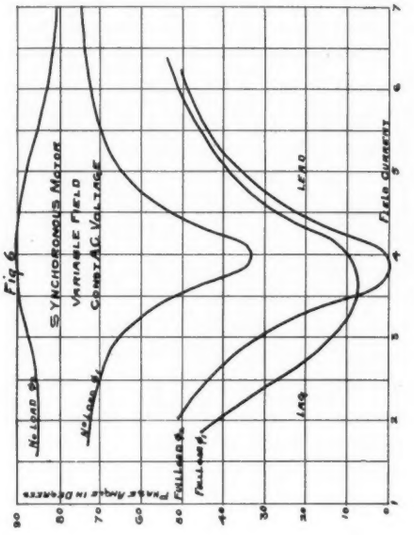
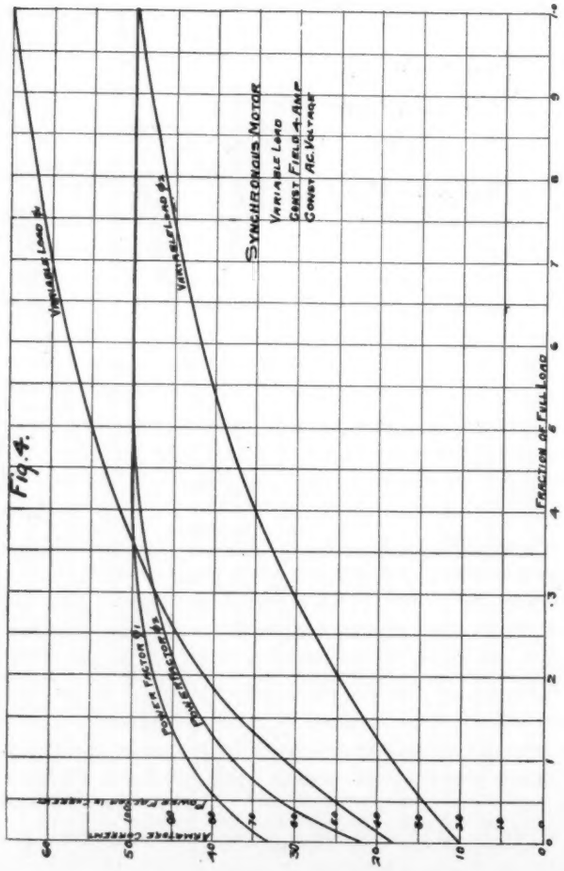


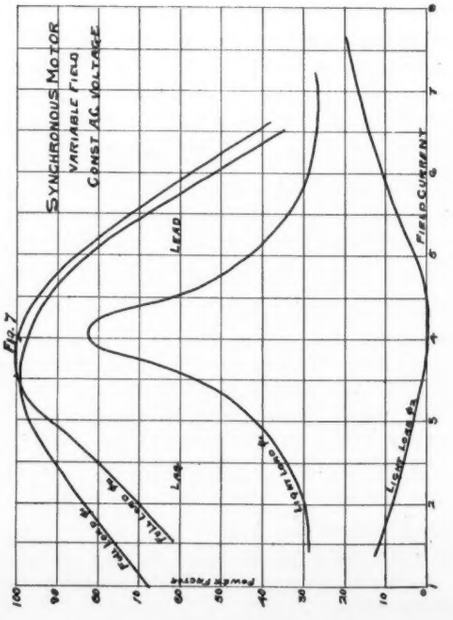
Fig:1- Syn Motor - Fig:2/Alt-Syn Motor and Converter Fig:3- Inv Rotary

Connections









motor and generator at any instant will come to a corresponding position, and a tendency to produce cross currents, with a general condition of instability in the system, as regards the phase relations of the E. M. Fs. Hunting comes from quick variations of the phase angle between the supply and the counter E. M. F., causing the motor to hunt or oscillate about its proper phase position. This is due to the inertia of the rotor, which requires a time element to bring it to its proper phase position when out of phase, and then the momentum carries it in oscillation beyond that position. This shifting of speed to maintain the proper phase angle may come from a difference of wave shape of the generator and motor, from a change of load, requiring a new phase angle to supply the proper current, or from change or variation in speed of the prime mover that is running the generator, causing momentary changes of speed. For this latter reason, generators that are running synchronous motors require much closer regulation of speed than under other circumstances. Hunting may be largely prevented by anti-hunting devices. Examples of these are thin sheets of copper, aluminum, or brass over the pole piece, or a large copper short circuiting wire around the end of the pole piece, to overcome the difference in wave shape of the supply and of the motor voltage.

The results of these two tests are compared in the plots of Figs. 5 to 9, which all have the field current as abcissae and illustrate the effect of varying the field current.

Plate 6 has the phase angle plotted as ordinates.

Plate 7 has the power factor plotted as ordinates.

Plate 8 has the wattmeter readings of the power supplied, plotted as ordinates.

Plate 9 has the wattmeter readings minus the I^2R loss plotted as ordinates.

Variation of the synchronous motor field varies the counter E. M. F. Since for a given mechanical load the power used is nearly constant, the phase relations of the E. M. Fs., and also the phase angle between the current and the terminal voltage, will then vary with change of field. With low field excitation, the current will lag considerably behind the terminal voltage, and as the field increases, the angle of lag will decrease, until it is zero at a point where the armature current is the least for a given mechanical load. An increase of field beyond that point will cause an angle of load of the current over the impressed voltage. There is one value of the exciting current, as we have seen, for which the armature current is a minimum and the power factor unity. For motors of good regulation, this value of the field current is nearly constant for different loads. In the machine studied, it is four amperes or a little less. The conclusion from all this is that a line current, which would otherwise lag, due to line inductance or inductive loads in other parts of the circuit, may be brought up to unity power factor or even be given an angle of lead, by over exciting the field of a synchronous motor so as to produce a leading current in that motor. Sometimes synchronous motors are run light, solely for the purpose of regulating the phase relations of the line, in which case the motor is termed a synchronous compensator, or occasionally a rotary condenser. Of course, a motor is limited in the amount of mechanical load it can carry, by the heating effect of its current, and so the amount of mechanical load it can carry decreases with decreasing power factor of either leading or lagging current.

In the first test on the mutual relations of the generator and synchronous motor, the generator voltage of 1,000 volts was transformed down to proper voltage for the machine. The motor was run with almost no load, generator field constant, moter field variable, and inductance between the motor and the transformer in each phase.

The second test was similar to the above, except that the generator fields were so varied as to keep the generator voltage constant at 1,000 volts.

The third test was somewhat similar, except that the generator fields were so varied as to keep the alternating current terminal voltage constant at 85 volts. The results of these three tests are compared in the plots of Figs. 10-15, all of which have the motor field current as abcissae.

Fig. 10 has the armature current plotted as ordinates.

Fig. 11 has the phase angle plotted as ordinates.

Fig. 12 has the power factor plotted as ordinates.

Fig. 13 has the motor wattmeter readings of power supplied, plotted as ordinates.

Fig. 14 has the generator field current plotted as ordinates.

Fig. 15 has the voltage at the motor and the low tension voltage of the generator plotted as ordinates.

The tests of Figs. 10-15 are very interesting, as they show the values and the relations of the current, generator voltage, alternating current voltage and terminal voltage, when there is the inductance of a transmission line, and varying conditions of generator and motor field excitation. This shows how an increased motor field excitation, decreasing the lag or increasing the lead of the line current, will raise the voltage at the end of the line, overcoming the line drop, or even making the motor terminal voltage greater than that at the terminals of the alternator.

The following is a mathematical examination of the motor conditions, where e =impressed voltage:

$Z = \sqrt{r^2 \text{ plus } x^2}$ = impedance of circuit of equivalent resistance r and equivalent resistance $x = 2\Pi NL$. Here note that if e_0 is motor terminal voltage, x, r and z refer to motor; if e_0 is generator terminal voltage, x, r and z refer to motor and line; if e_0 is voltage induced by generator armature, x, r and z refer to motor, line and generator.

e_1 = Counter E. M. F. of motor, induced by the varying field.

i = current.

p = mechanical power delivered.

The fundamental equation to start from is

$$e^2_0 - e^2_1 - z^2i^2 - 2rp = 2x\sqrt{i^2i^2_1 - p^2}$$

Rewritten, this is

$$(r^2(e^2_1 \text{ plus } z^2i^2) - z^2(e^2_0 - 2rp))^2 \text{ plus } (rx(e^2_1 - z^2i^2))^2 = x^2z^2e^2_0(e^2_0 - 4rp)$$

$$e_1 = \frac{e_0 z}{r}\sqrt{\frac{1}{2}\left(\frac{1-2rp}{e^2_0}\right) \text{ plus } \frac{x\cos\phi}{z} \text{ plus } \frac{r\sin\phi}{z\sqrt{1-4rp}}}$$

$$i = \frac{e_0}{r}\sqrt{\frac{1-2rp}{2e^2_0} \text{ plus } \frac{x\cos\phi}{z} - \frac{r\sin\phi}{z\sqrt{1-4rp}}}$$

Whence the capacity, or maximum output possible, becomes known as the point where, in the above,

$$\sqrt{e^2_0 - 4rp} = 0, \text{ or } p = \frac{e^2_0}{4r}$$

$$\text{Whence } e_1 = \frac{ze_0}{2r}$$

$$i = \frac{e_0}{2r}$$

Let us make a comparison of the synchronous motor and the induction motor, particularly with a view of studying the characteristics of the synchronous motor. In the first place, it may be said that the synchronous motor is not by any means "fool proof," and requires intelligent and experienced care to operate to advantage. Further than that, its characteristics may largely be an advantage or a disadvantage, according to circumstances. Particularly is this the case in regard to starting, as machinery which runs constantly and needs constant speed may be run with advantage by synchronous motors, but machinery which requires frequent starting or stopping, or which varies in the speed required, would better be attached to an induction motor. Heavy, sudden variations of load are also hard on a synchronous motor. These facts are very apparent, since the synchronous motor starts with small starting torque, and has a large torque only

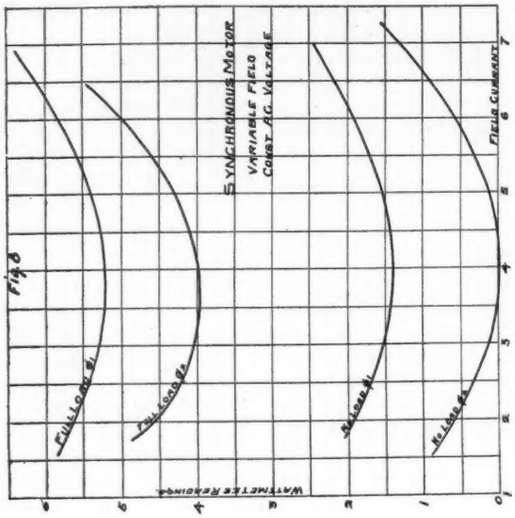


Fig 8
SYNCHRONOUS MOTOR
VARIABLE FIELD
CONST. A.C. VOLTAGE
WATTMETER READINGS
FIELD CURRENT
FULL LOAD
75 PER CT.
50 PER CT.
25 PER CT.

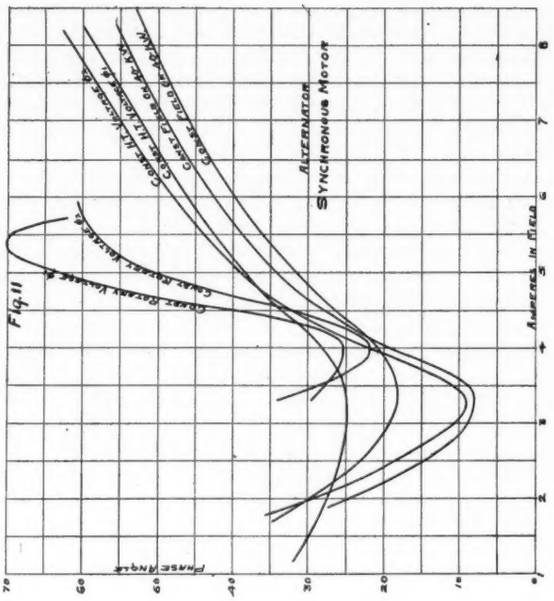


Fig 11
ALTERNATOR
SYNCHRONOUS MOTOR
PHASE ANGLE
AMPERES IN FIELD

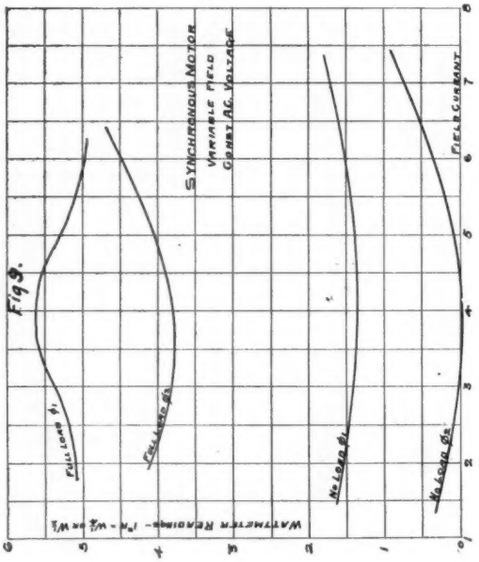


Fig 9.
SYNCHRONOUS MOTOR
VARIABLE FIELD
CONST. A.C. VOLTAGE
WATTMETER READINGS
FIELD CURRENT
FULL LOAD
75 PER CT.
50 PER CT.
25 PER CT.

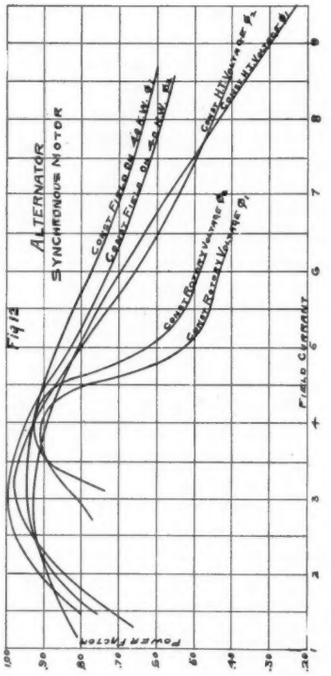


Fig 12
ALTERNATOR
SYNCHRONOUS MOTOR
POWER FACTOR
FIELD CURRENT

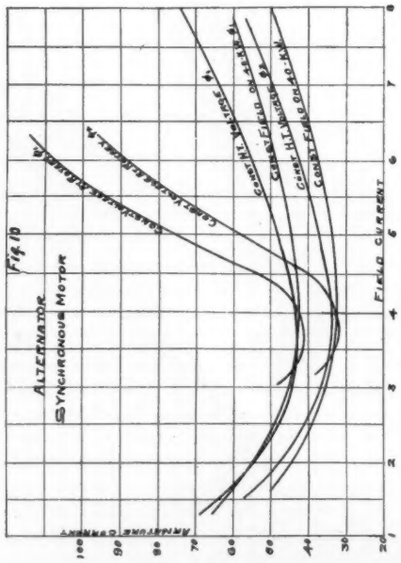


Fig 10
ALTERNATOR
SYNCHRONOUS MOTOR
ARMATURE CURRENT
FIELD CURRENT

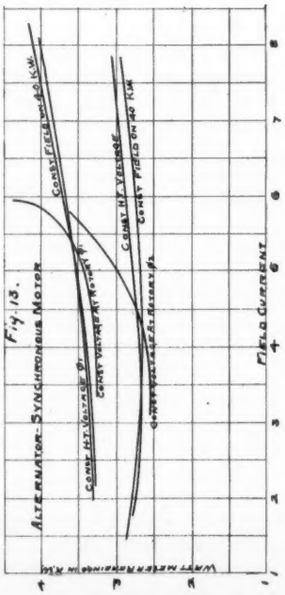


Fig 13.
ALTERNATOR-SYNCHRONOUS MOTOR
WATT METER READINGS IN K.W.
FIELD CURRENT

at synchronous speed, though at this speed it has several times full load torque; and since a load heavy enough to check the speed, even though momentary, may cause the motor to fall out of step, when it can only be started by an attendant. If from any other cause, as failure of current supply, sudden lowering of the E. M. F., or sudden change of the generator speed, the synchronous motor falls slightly out of step, it is liable to stop, and then requires an attendant to start it. An induction motor will accommodate itself to varying conditions, and will even start without attention from an attendant, if momentarily stopped. The synchronous motor is very dependent on stability of conditions in the line, and in turn it impresses its own peculiarities on the line, and augments line irregularities. It also requires certain special station appliance, and a direct current for exciting its fields. This field circuit is liable to field discharge, if the exciting current is suddenly broken, or if it has excessively high E. M. F., by induction from the armature when the field circuit is open, as may be the case in starting. These facts seem to indicate that the induction motor is the better machine for use, except where constant speed is necessary, and it is true that in most cases small synchronous motors would be out of place, complex in operation, and liable to accident, while the induction motor is much more flexible. Under certain conditions, however, especially for larger machines, it possesses some distinct advantages. Although it is sensitive to line conditions, it may also be made corrective to line faults. Thus an induction motor must always produce a lagging current, and augments the lag from the line inductance; but the synchronous motor can be so regulated as to run at unity power factor, its most efficient condition, or to produce a leading current, and raise the voltage at the end of the line, thus neutralizing the inductance of other parts of the line, and overcoming the line drop of voltage, so as to produce better regulation. It is also generally cheaper to build, and of higher efficiency of operation. Its advantageous use is particularly in central stations at the end of a long transmission line. It will be found that rotary converters possess these advantages, without some of the disadvantages.

Fig. 16 is direct current voltage at brushes plotted as ordinates, and also the ratio of direct current to alternating current voltage as ordinates, with direct current load current as abcissae.

Fig. 17 is alternating current in line plotted as ordinates, with direct current voltage at terminals plotted as abcissae.

Fig .18 is efficiency plotted as ordinates, with direct current load current as abcissae.

Fig. 19 is power factor plotted as ordinates, with direct current load current as abcissae.

Preliminary tests in compounding with direct current voltage kept constant at 114, by varying the alternating current voltage, and rotary field kept constant at 2.6, 4 and 5.5 amperes, respectively, are shown in Figs. 20 and 21.

Fig. 20 is efficiency in the above tests plotted as ordinates, with direct current load current as abcissae.

Fig. 21 is power factor plotted as ordinates, with direct current load current as abcissae.

Two tests on compounding, in contrast to the above, with inductance in the circuit corresponding to line inductance, are shown in Figs. 22 and 23. The low tension voltage is kept constant at 85, corresponding to generator terminal voltage very nearly, as it would be likely to be kept at a generating power house, and the natural fall of direct current with increasing load is neutralized by increasing the rotary field excitation, thus decreasing the angle of lag and finally increasing the angle of lead so as to increase the motor alternating current terminal voltage. By this means the direct current voltage is kept constant, at 101 in the first test, beginning with 2.5 amperes rotary field current, and at 118.5 volts in the second test, beginning with 4 amperes rotary field current. In thus changing the phase angle and the terminal voltage, by varying the field, the rotary converter is subject to the same peculiarities as the synchronous motor.

Fig. 22, the alternating current rotary terminal voltage plotted as ordinates, with the direct current load current as abcissae.

Fig. 23 is efficiency plotted as ordinates, with direct current load current as abcissae. It may be compared with Fig. 21 of the preceding tests. It shows the effect of the increasing field of the rotary, in changing the power factor, though this change is not entirely due to that cause. For this machine, with the particular inductance that was in the line, the best conditions of operation, considering power factor, efficiency, and regulation, seemed to be in the first of the inductance tests, when carrying full load with about four amperes rotary field excitation.

In compounding, in actual practice, a certain small proportion of the direct current current generated is taken through separate field coils, and so the field excitation increases as the load increases. When inductance is in the line, as in long distance transmission, or occasionally when a choke coil is inserted for the purpose, the natural lag of the current is neutralized, just as with the synchronous motor, by the increased field excitation, and thus the alternating current terminal voltage is raised sufficiently to maintain constant direct current voltage. It is thus of particular value for railway use, as it will take power from a long distance alternating current transmission line, the most economical method of transmission, and convert it into direct current at constant voltage under varying loads. If so wound as to continually take a high power factor or a leading current to maintain proper terminal voltage, it may be made very useful in neutralizing lagging currents in the line, just as with the synchronous motor.

The remaining plates show tests on the machine run as an inverted rotary converter, first with constant speed under varying load, maintained by varying the field excitation, and second with constant field excitation, and varying speed caused by varying load.

Fig. 24 is field excitation plotted as ordinates from the first test, and speed under constant field plotted as ordinates from the second test, with load current as abcissae.

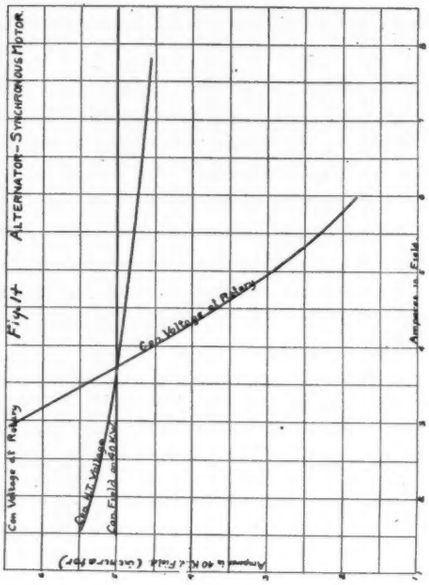
Fig. 25 is real and apparent efficiencies plotted as ordinates with alternating current load current as abcissae.

Fig. 26 is power factor plotted as ordinates with alternating current load current as abcissae.

Fig. 27, the last, is regulation plotted as ordinates, with the direct current as abcissae.

An inductive load, or lagging alternating current from the inverted rotary, may cause racing of the armature. With low field excitation, a lagging current derived from the machine still further decreases the field strength and thus increases the speed. An increase of frequency may still further increase the current lag, and its demagnetizing effect, and so the machine race to its destruction. Preventative measures, as circuit breakers, or mechanical connection of the source of exciting field current, is needed to insure the safety of the machine from racing.

In considering the E. M. F. and current relations of alternating current and direct current sides of the rotary converter, we find that the maximum instantaneous alternating current voltage occurs when the collector ring connection is under the direct current brushes, or in the position where alternating current voltage equals direct current voltage. Then in single phase connection $E_1 = E/\sqrt{2}$, where E_1 is the A. C. voltage and E is the D. C. voltage. Then as $EI = E_1 I_1$, neglecting the power factor and motor losses, we find $I_1 = \frac{I}{\sqrt{2}}$. In a similar way, by graphical construction, we may determine the theoretical relations of currents and E. M. Fs. These are shown below, taking D. C. as unity.


Alternator-Synchronous Motor
Fig 14
Amperes in Field

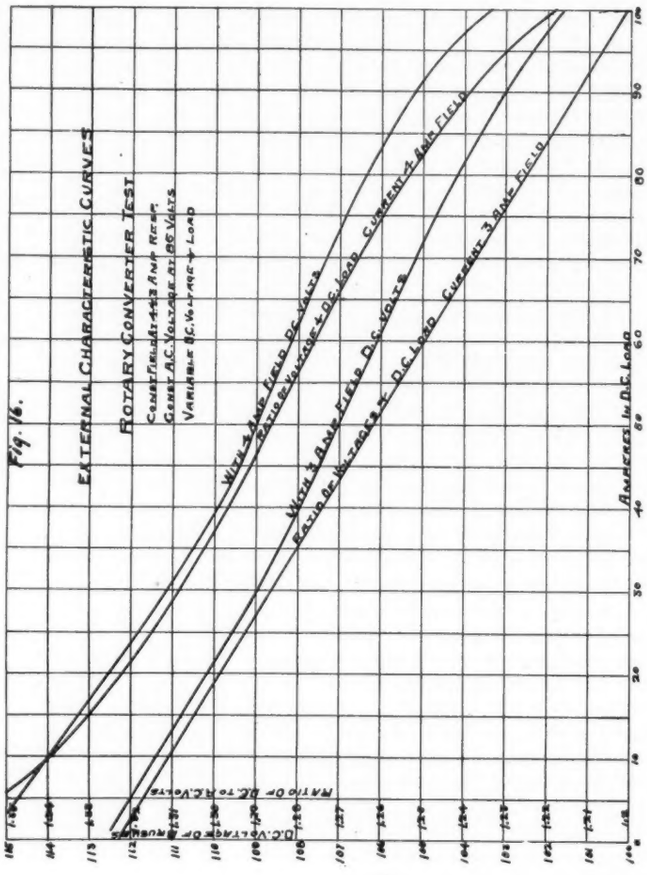


Fig. 16.
External Characteristic Curves
Rotary Converter Test
Amperes in D.C. Load

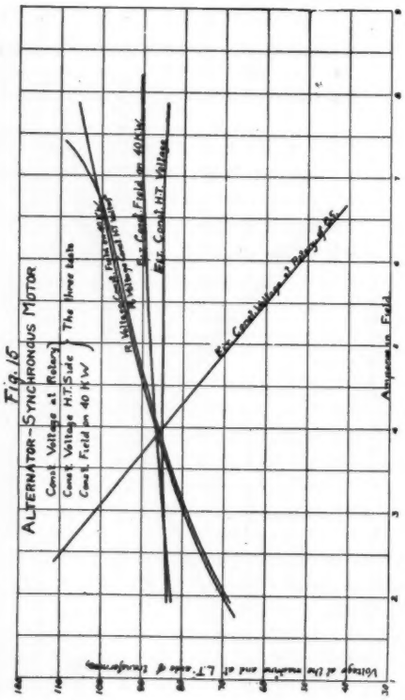


Fig. 15
Alternator-Synchronous Motor
Amperes in Field

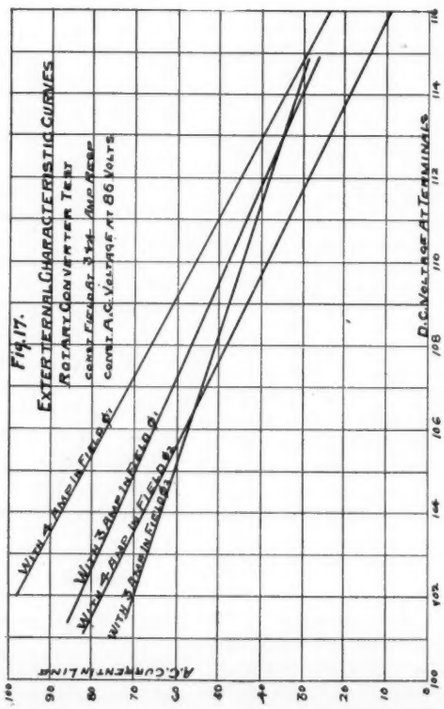


Fig. 17.
External Characteristic Curves
Rotary Converter Test
D.C. Voltage at Terminals
A.C. Current in Line

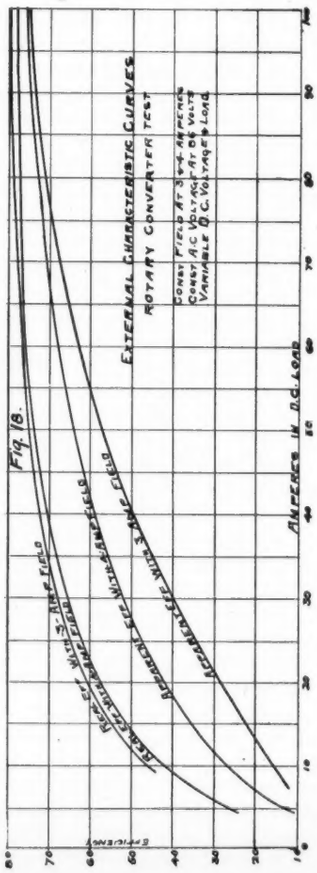


Fig. 18.
External Characteristic Curves
Rotary Converter Test
Amperes in D.C. Load

	Single Phase	2 Phase	3 Phase	4 Phase	6 Phase	12 Phase	n Phase
E_1 between ring and neutral pt.	$1/\sqrt{2} = .354$ for all of these phases						
E^1 between adj. collector rings	$\frac{1}{\sqrt{2}} = .707$	$\frac{3}{2\sqrt{2}} = .612$	$\frac{3}{2\sqrt{2}} = .612$	$\frac{1}{2} = .5$	$\frac{1}{2\sqrt{2}} = .354$	$= .183$	$\frac{\Pi}{\sin n}\frac{}{\sqrt{2}}$
Current per line	$\sqrt{2} = 1.414$	$\sqrt{2}/\sqrt{3} = .817$	$\frac{2}{3\sqrt{2}} = .943$	$1/\sqrt{2} = .707$	$\sqrt{2}/3 = .472$	$= .236$	$\frac{2\sqrt{2}}{n}$
Current between adj. lines	$\sqrt{2} = 1.414$	$\sqrt{2}/\sqrt{3} = .817$	$\frac{2\sqrt{2}}{3\sqrt{3}} = .545$	$1/2 = .5$	$\sqrt{2}/3 = .472$	$.455$	$\sqrt{2}\ \sin \Pi/n$ / n

Slight variation in these values may be expected for voltage, due to I^2R losses and to variation of wave form, and also power factor. Thus armature self-induction reduces the induced alternating E. M. F. below the impressed voltage, and thus the direct current voltage is reduced, for lagging currents. For leading currents, armature self-induction increases the alternating induced E. M. F., and thus the direct current voltage. The values of current will then vary accordingly.

One of the most peculiar and interesting things about the rotary converter is the armature heating effects. The actual current in the armature conductors is the vectorial sum of the alternating current input and the direct current output, and the two largely neutralize each other, thus lessening the I^2R loss. Thus we find in an n phase machine, with I^1 the effective value of the alternating current corresponding to the direct current, and qI^1 the enery current for mechanical loss and molecular friction, the actual current in the armature coil, in terms of the direct current I, is

$$I^1{}_0 = I/2\sqrt{\frac{8(1 \text{ plus } q)^2}{n^2 \sin^2 \Pi/n} \text{ plus } 1 - \frac{16(1 \text{ plus } q \cos w)}{n\Pi \sin \Pi/n}}$$

In this, w is the angle by which a coil is displaced from its position of maximum voltage. If T^1 is the ratio of the rotary converter armature heating to the armature heating of a direct current generator of the same output, then we find that

$$T^1 = (1 \text{ plus } 2q)\left(\frac{8}{n^2 \sin^2 \Pi/n} \text{ plus } 1 - 16/\Pi^2) - 2q(1 - 8)/\Pi^2\right)$$

An exception to the above is the two circuit single phase machine, where

$$T^1 = 1 \text{ plus } \frac{16(1 \text{ plus } q)^2 \text{ plus } 6}{9} - \frac{16(1 \text{ plus } q)}{3\Pi}$$

The above looks complicated, but assuming q = .04, we have, with D. C. = 1 as a basis:

	1 circuit single phase	2 circuit single phase	3 phase	4 phase	6 phase	12 phase	n phase
T^1	1.475	1.149	.585	.385	.267	.201	.187
Capacity ..... $= \frac{1}{\sqrt{T^1}}$	.825	.933	1.31	1.61	1.94	2.24	2.31

The above discussion is for energy current alone. With wattless component also, a proportion of the above, equal to the square of the per cent of energy current which is the wattless current, has to be added to the above loss.

In single phase machines, the armature reaction tends to shift the magnetic flux rapidly across the poles with double the frequency of the alternating current. As a result, the commutator brushes need to be shifted from a position midway between the poles, but this reaction is largely reduced by damping of the magnetic structure. With polyphase machines, the direct current and alternating current armature reactions almost wholly neutralize each other, and so give no trouble, and no change of field is required with change of load. The same conditions exist in the inverted rotary.

If we take any number of equally distant pairs of opposite points on a rotary armature, and connect the two ends of each pair to an auto-transformer, or electric circuit, interlinked with a magnetic circuit, then the centers of these auto-transformers may be converted to a wire which will form a neutral between the commutator brushes. The whole will then form a three-wire distributing system from one rotary. In this, the neutral between the two commutator brushes will have nearly equal potential between itself and each of the brushes, and will carry double the current of each of the outside wires.

The limitation of voltage imposed by high frequency supply and the comparison of low and high frequency converters with regard to ease of design of commutator, may well be considered at the same time. The limits of voltage and of frequency are mutually dependent on each other, and are set by the commutator construction difficulties. It may be said that the limit of commutator speed is 4,5000 feet per minute, and beyond this there begins to be danger that the commutator segments will buckle, from the high centrifugal force. The speed of a large armature may be said to be 600 revolutions per minute. For this, the number of poles p would depend on the frequency. For 60 cycles it would be 12 in the above example. For 40 cycles it would be 8. The voltage between adjacent commutator bars is about 13 volts. At 4,500 feet per minute peripheral speed the commutator diameter is 90 inches, which is very large. Even then, for 50 cycles, the direct current voltage could not be as high as 550, the amount common for street car service, as this would require 550 p/13=500 commutator segments, allowing less than one-fifth of an inch width for each segment, which, for mechanical reasons, would be too small. Thus the voltage is limited by the frequency. A low frequency converter would require a less number of poles, and so of commutator bars, thus increasing the width of the bars for a given voltage, and simplifying commutator construction.

The remarks made under synchronous motors on hunting also apply to the rotary converter, and high frequency also increases the tendency to hunt. For this reason, as well as commutator design, a low frequency of 25 cycles is better adapted to the rotary converter than a higher frequency of 60 cycles.

In a comparison of the rotary converter with the induction generator, it may first be said that the rotary possesses the peculiarities of the synchronous motor very largely, but this is not so objectionable, where these peculiarities would be

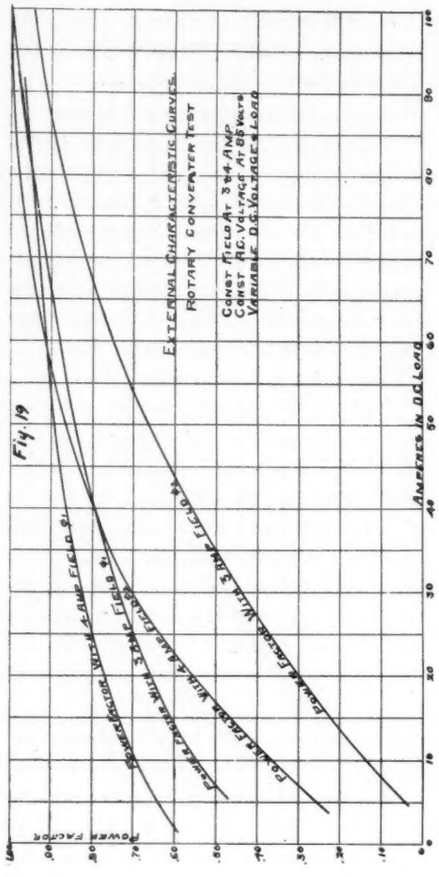


Fig. 19
External Characteristic Curves.
Rotary Converter Test
Amperes in D.C. Load

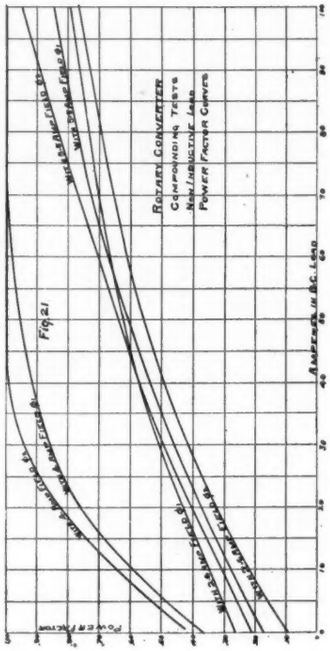


Fig. 21
Rotary Converter
Compounding Tests
Non-Inductive Load
Power Factor Curves
Amperes in A.C. Load

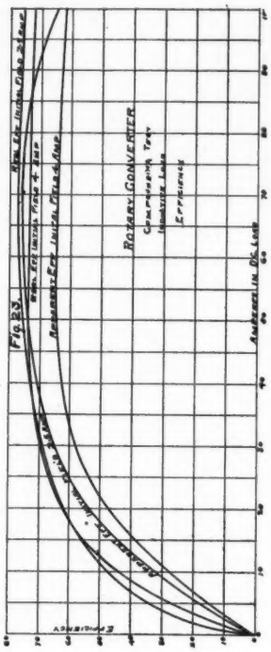


Fig. 23
Rotary Converter
Efficiency Curves
Amperes in D.C. Load

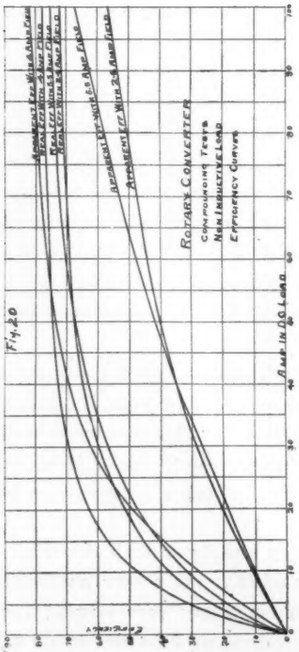


Fig. 20
Rotary Converter
Compounding Tests
Non-Inductive Load
Efficiency Curves
Amps. in D.C. Load

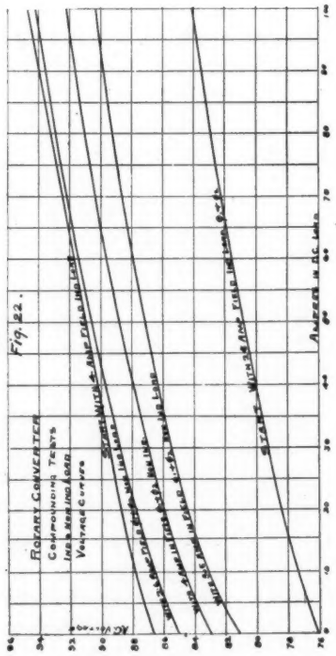


Fig. 22.
Rotary Converter
Compounding Tests
Inductive Load
Voltage Curves
Amperes in A.C. Load

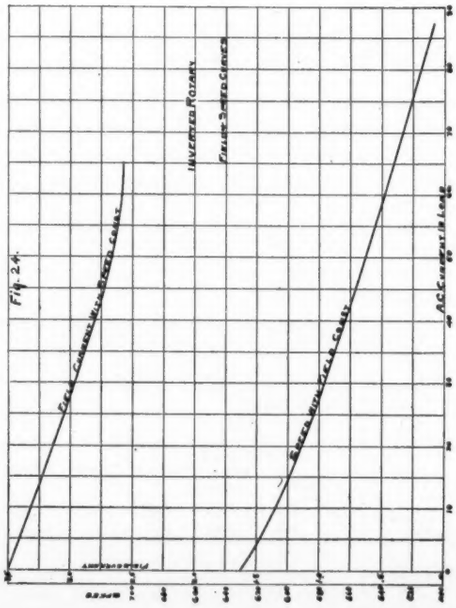
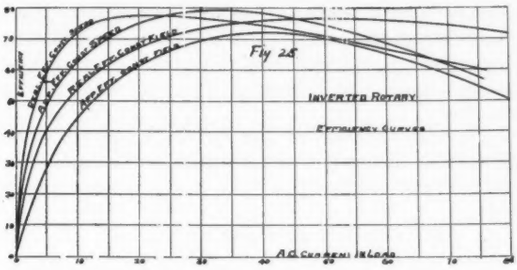
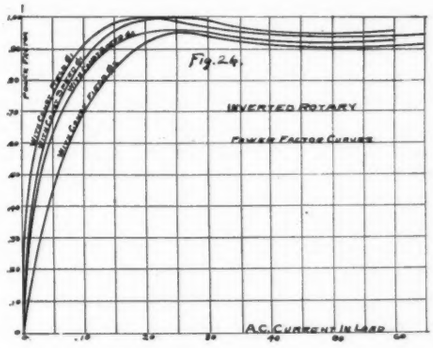


Fig. 24.
Inverted Rotary.
Full Speed Curves
Amperes in A.C. Load

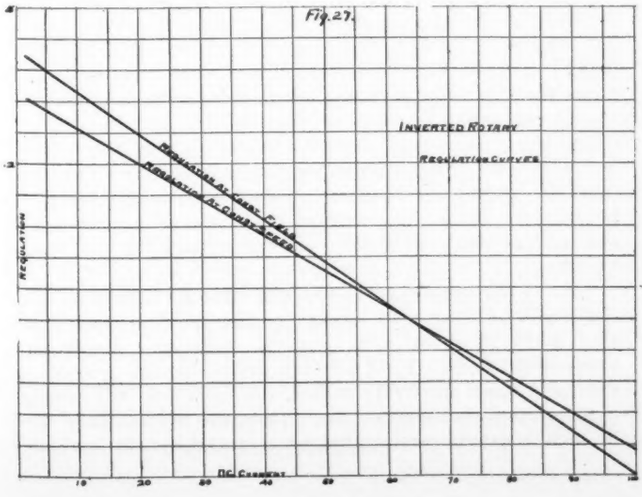
an objection, as would be the case in operation of most synchronous motors. Thus the necessity for an intelligent attendant is met by the fact that a rotary would usually be installed in large sizes in sub-stations, where there would be



such attendance. The machine would furnish its own excitation, and may be so compound wound as to prevent a falling off of voltage. Thus the close connection between alternating current and direct current voltage is made unobjectionable. Starting is simpler than with the synchronous motor, as there is no load to accelerate, and on occasion it may be started from the direct current side. The rotary is, of course, subject to the close connection with the system of a synchronous machine, while a motor-generator set, if run by an induction motor, is comparatively uninfluenced by irregularities in the system. The motor-generator set may have independent control of the direct current voltage where desired. It is also to be preferred in small units, as it requires very little intelligent attendance.



It seems to me the main deciding point in the comparison of the rotary converter with the motor generator set is in first cost and efficiency, and here the rotary has the advantage. there being only one machine. The rotary efficiency is also greater because of the lessened heat loss, due to the neutralizing effect upon the I^2R loss of direct current and alternating current in the single armature. The rotary, however, requires a quite low alternating current applied voltage, because of the definite ratio between alternating current and direct current voltage, while the induction generator set may use a comparatively high voltage at its terminals. It is for this reason that the rotary converter is quite common in the East, where one transformation would be needed anyway to reduce the voltage from the line voltage; while in the West, with its extremely high tension transmissions, one step-down transformer would be required for operation of a motor generator set, but a second step-down transformer, with its losses, would be required for rotary converter operation. Because of this, rotary converters are very uncommon on the Pacific Coast.



TIMBER TESTING AT PURDUE.

A long series of experiments has been completed at Purdue University affecting certain processes to increase the life, strength and physical qualities of timber. These processes are regarded necessary because of the steady diminution of the timber supply. The feeling is prevalent that everything possible should be done to increase the durability of the timber that is now being used for various purposes. The experiments at Purdue have been made chiefly in the interests of railroads by making mechanical tests of the ties treated by different processes. Over 400 ties were used, and upward of 600 tests were made. The timber-testing laboratory at Purdue is the one used by the government at the St. Louis Exposition.

FEATHER RIVER POWER TRANSMISSION.

The Western Power Company, which has been doing preliminary work in the Big Bend and Big Meadows districts, in Plumas County, California, for several years, has completed its financial engineering, and is expected to get down to practical construction work before long. It is considered by engineers one of the greatest projects in its ultimate possibilities outside of Niagara Falls. An office has been established in San Francisco, and another will be located at the power site at the Big Bend of the Feather River. The New York engineering firm of Viele, Cooper & Blackwell is in charge of the construction work. The 165-mile transmission line to San Francisco is to start from the Big Bend, where a post-office is to be established and a small town is springing up. The main power house, which is to be constructed near the Big Bend tunnel, is to have sufficient room, ultimately, to accommodate generating units with a combined capacity of 120,000 horsepower. The first section will be built to house units of a total capacity of 40,000 horsepower.

The largest marine gasoline engine in the world has been shipped from Baltimore to Russia. It is of 1,600 horsepower, and is one of four ordered by the Czar's Government, at a cost of $100,000, to go into lake submarine torpedo boats.

A motor-driven rail mill is in operation at the Edgar Thompson plant of the Carnegie Steel Company at Bessemer, Pa. It is equipped with two 1,500-horsepower, 30-pole, 220-volt, direct-current motors overcompounded 15 per cent, which operate at from 100 to 125 revolutions per minute. Each motor carries a 125,000-pound cast-steel segmental flywheel which relieves it from the extreme shocks of rolling. The power delivered by each motor ranges from 950 to 1,450 horsepower in rolling rails, with occasional jumps to 1,700 horsepower; the friction load on the mill running light is about 500 horsepower.

GAS-DRIVEN ELECTRIC POWER SYSTEM OF THE WARREN AND JAMESTOWN RAILWAY.*

J. R. Bibbins.

More or less skepticism prevails even today regarding the ability of a gas power plant to do the work that has formerly been done by steam power. In the unusually severe conditions surrounding the power service at Warren, Pa., a most convincing example is found of the efficiency and reliability of a properly constructed gas power plant.

To give a correct idea of operating conditions at Warren it would be necessary to review in perspective, as it were, the main features of the system as a whole, embracing not only the power plant but also the distribution system, road bed, equipment and traffic. It is sufficient to say here that a gas engine plant of 1,000 horsepower capacity, in two units, is operating, without steam reserve, an entire railway system totaling 42 miles of road, half city and half interurban. The latter traverses a difficult country with but two to four cars in service, all of unusual size (35 tons), high speed (50 miles per hour) and powered 200 horsepower per car. Upon this plant, which regularly operates 80 to 90 per cent of the time, the entire traction service of an important community depends.

At the time of its organization, several years ago, the Warren Street Railway Company decided to experiment with gas power for running their direct current city system. Vertical single acting type gas engines were installed, and the results so greatly exceeded those possible with gas fired boilers and steam machinery as to fully warrant all power extensions in gas machinery. For the more important alternating current interurban service, a horizontal double acting type gas engine was chosen in view of the heavy duty that would be imposed upon it. In the operation of the direct current urban system a storage battery was at all times available, not only to take care of emergencies, but to assist in the more uniform loading of the power equipment. With the alternating current interurban service, however, such a reserve, although much needed, was evidently not available; the new power equipment must not only sustain the load unaided, but also render a service proportionately more certain owing to the danger of isolating passengers in mid-country. That it has accomplished this result is shown by the records of practically uninterrupted operation of 18½ to 24 hours per day, including Sundays, and a complete tie-up of the system has yet to occur traceable to gas engine trouble alone.

With a definite operating schedule the load demands may, in a sense, be anticipated; for instance, when starting on the even and half hour from terminals. But practically, it is impossible to anticipate their extent, with the result that maximum generating capacity must be kept continually in service, although at one time the load may fall to practically nothing and at the next instant rise to the limit of the plant capacity.

At the present time express cars on the regular daily runs carry loads varying from 3 to 15 tons; it is nothing unusual for these cars to haul 15 barrels of oil, or a load of dressed oak timber, which pulls heavily on the steep grades. It is unnecessary to emphasize the fact that this kind of load is the worst that a reciprocating engine can be called upon to sustain; the fact that the Warren plant is capable of meeting these fluctuations without rapid deterioration should furnish a convincing proof of the stability of the modern gas engine.

Another point of importance bearing upon the success of a power plant is the character of labor available. Owing to the distance of the plant from the city and its complete isolation after running hours, it is difficult to retain skilled operatives. Thus, at the present time, although one such were quite inexperienced, most of them having come up from man is retained as superintendent, the remaining attendants the ranks in street railway service or from outside employment. During the past six months, these men have acquired sufficient knowledge and skill to enable one of their number, a comparatively young man, to take entire charge during the night run.

A general survey of the operation of the Warren gas engine plant, up to the present time, brings to mind the following points that would now seem to have been established:

1. Ability to handle variable loads.
2. Regulation suitable for alternating current parallel operation.
3. Effect of misfires negligible.
4. Sufficient reliability for regular daily service.
5. Deterioration from wear quite normal.
6. General character of labor required not above the ordinary.
7. Oil and water consumption low. Automatic systems desirable.
8. Automatic starting system quite sufficient for any emergency.

Not the least impressive feature of the Warren plant is the ease in which the gas engine units are operated in electrical parallel. They are synchronized by the ordinary lamp method and on opening throttle. The author has observed the entire operation of unloading, synchronizing and loading again accomplished within a period of 25 seconds without the least evidences of surging at the instant of closing of the switches. When synchronizing, loads are distributed in the manner usual with steam machinery, the governor adjustment being accomplished with an adjustable lever arm attached to the regulator by a spring cushioned oil dash pot. In practice the governors are so adjusted as to give practically the same port opening at the mixing valves, which insures a fairly even distribution of load at the switchboard. During the excessive load fluctuations the units showed no tendency to hunt; in fact, operated with the greatest stability on the heavier loads.

The effect of misfires on parallel operation has been subject to much conjecture and it is of interest to know that, although misfires occur now and then as they are bound to do, in not a single instance have electrical troubles resulted during normal operation. With one cylinder entirely isolated by a defective igniter it is, of course, probable that some surging would result, but the misfires that do occur are so seldom continued and are so easily remedied that no trouble whatever is apprehended from this source.

In the ignition system, the well-known electric "hammer break" style of igniter has proven the most serviceable, and with very ordinary care, no trouble is experienced in obtaining sufficiently reliable ignition for polyphase working. Originally, some annoyance was caused by the sweating of igniter plugs while the engine was starting from cold, but this was readily overcome by venting them to the atmosphere. A complete stoppage from defective ignition is very improbable, for with both storage batteries and dynamo, two combinations of current are available at each combustion chamber. Further, the igniter circuit to each cylinder is separated into two independent sections, each controlled by individual switches.

As to the general reliability, the facts presented are self-explanatory. After a six weeks' run the unit first started was shut down to examine its internal condition. Every part was found to be in good working order without evidence of excessive wear or stress; in fact, the cylinders still retained their original tool marks. Since then, the engines have been in such constant service that no opportunity has presented

* Abstract of a paper read before the Engineers' Society of Pennsylvania, June 5, 1906.

itself for further inspection, and all detail parts are operating in their original condition with the exception of the igniters. These are, of course, periodically removed for cleaning during the early morning shut down. It is a significant fact that in spite of the hard service, exhaust, admission and mixing valves, piston rods, glands, connecting rods, main bearings and cylinders have operated without mishap and show no evidences of abnormal deterioration after seven months' daily run. The imported Hartung regulators have developed a slight wear in pins, but this will be corrected by improved lubrication. The one accident occurring during this period was the breaking of a metal cage surrounding the piston rod packing glands, which was caused by excessively thin metal due to the accidental shifting of the sand core in casting. Piston rods have done exceptionally well in regard to wear owing to the efficient packing and method of gland lubrication; both rods have retained their original polish and run quite clean without tendency to gum.

Undoubtedly no small part of the success in operation is traceable to the oiling system. Realizing that oil is an absolute essential and that oilers are human beings and, therefore, not infallible, the designer has relieved them of the greater part of their responsibility by using a continuous circulating and filtering system. This also results in a great saving of lubricant, which in turn encourages the use of the highest grade oil. Cylinder lubrication is particularly effective owing to the judicious application of lubricant at just the right time. The oil is automatically injected into the cylinder at several points, but only on the induction stroke; not promiscuously, as is almost universally done, resulting in the carbonization of by far the largest proportion. By the end of the compression stroke the oil is thoroughly distributed. The quantity of cylinder oil used is somewhat higher than in other engines of the same size and design, but this is partly due to the fact that more or less oil is drawn out of the system weekly for use in auxiliaries around the plant, and is replaced by fresh oil. Some cylinder oil is also saved from the piston rod glands, as all drainage is caught, mixed with old engine oil, and utilized in crank cases of the exciter engines for which no oils are regularly purchased. A gallon of cylinder oil per engine per day is usually sufficient with clean gas.

Water consumption, however, is rather low, due to the fact that the average load on the engines is considerably below rating, and full-load demands are of short duration. Owing to the abundant supply available, the jackets are run unusually cool. It is noteworthy that successful circulation is being obtained from the elevated tank without the use of a pressure pump to supply pistons. At Warren the extraordinary purity of the water makes clogging of water ducts improbable, and 10 pounds hydrostatic head may therefore be depended upon with entire safety.

The automatic compressed air starting mechanism has proven to be one of the most effective details of design and has never failed, providing the proper pressure is maintained in the tanks and the ignition is in good working order. In starting the engines, only two valves are manipulated, viz., compressed air valve and the gas valve, and usually the engine "catches" its ignition in two or three strokes, coming rapidly up to speed within one minute.

SUMMARY OF OPERATING COST DATA.

SYSTEM	A. C. Interurban System Only		A. C. Interurban & D. C. Urban		A. C. Interurban & D. C. Urban	
MONTH, 1905-06.	Dec. and April		Jan., Feb., Mch.		May†	
Interurban Schedule	1½ Hours		1½ Hours		1 Hour	
Number of Cars in all, Regular Service ... Passenger	2		2		3	
Number of Cars in all, Regular Service ... Express	1		1		1	
Weight of Cars	35 Tons		35 Tons		35 Tons	
Headway	90 Minutes		90 Minutes		60 Minutes	
Lay Over	50 Minutes		50 Minutes		20 Minutes	
Operating Time	17½ Hours		17½ Hours		18½ Hours	
Total Number Round Trips	14		14		20	
Total Mileage per Car	315		440		440	
Car Miles per Day—Interurban	630		630		880	
" " " City			2381		2381	
Total Car Miles	630		3011		3261	
Ton Miles per Day—Interurban	22050		22050		30800	
" " " City			27310		27310	
Total Ton Miles	22050		49360		58110	
Average Tonnage per Day	35		16.4		17.82	
	Month	Day	Month	Day	Month	Day
Coal Fuel Gas	$257 10	$8 43	$382 90	$12 76	$394 95	$12 74
Wages	296 00	9 79	371 00	12 37	371 00	12 37
Oil	80 00	2 65	80 00	2 63	80 00	2 63
Sundry Supplies and Repairs	100 00	3 31	100 00	3 29	100 00	3 29
	$733 10	$24 18	$933 90	$31 05	$945 95	$31 03
Total Cost per Operating Hour	$1.38		$1.774		$1.677	
" " " 24 Hours	1.01		1.295		1.294	
" " " Car Operating Hour	0.645		0.194		0.166	
" " Average Car Mile	3.84c		1.031c		0.95c	
" " Average Ton Mile	0.1096c		0.0629		0.0534	
	Cu. Ft.	Cost	Cu. Ft.	Cost	Cu. Ft.	Cost
GAS CONSUMPTION per						
Average Car per Hour	1503	22.5c	532	8.04c	354	6.81c
" Car Mile	89.3	1.34	2803	0.427	26	0.391
" Ton Mile	2.55	0.0383	1.72	0.0261	1.46	0.022

†May expenses (except gas) averaged on 30-day basis.

Warren City System	Sheffield	N. Warren	City	Total or Avg
Length of line (miles)	11	3	7	
No. cars in regular operation	2	1	4	7
Headway, minutes	60	20	15	
Weight of cars (avg. tons)	18	15	10	11.5
Operating hours per day	17	17	17	17
Car miles per day	374	102	1905	2381
Ton miles per day	6730	1530	19050	27310

In the preceding table the total operating costs are summarized, on a basis of car and ton mile, for three definite operating conditions. As the one hour schedule has been in force only about one month, the costs for May may not be quite as representative as those covering 1½-hour headway. Further, the costs for December and April are, if anything, high, for the reason that during April the interurban plant furnished some power to the urban system during some work on the electrical machinery, although the results are considered as applicable to the interurban system only. In order to render the results from May more comparable with those of shorter months, the costs (except gas) are figured on a basis of 30 days.

Comparing these costs, the fact appears that the entire 42 miles of railway is now being operated for about $31 per day, or $1.67 per operating hour. The interurban system, running alone, averaged a little under .11c per ton mile, or 3.8c per car mile total operating costs. With the city system serving to increase the load factor of the plant, the total

operating cost per ton mile was reduced to .05c, practically half, and the cost per car mile to less than 1c. Comparing these costs with those of independent operation of alternating current and direct current plants respectively, a net saving in fuel of approximately 20 per cent has been realized. It is interesting to note the interurban cars alone required 89 cubic feet of gas per car mile, or 2½ cubic feet per ton mile; at present the average gas consumption is 26 cubic feet per car mile and 1½ cubic feet per ton mile. Further, note that the effect of shortening the schedule with a third interurban car is barely noticeable on the expense sheet, but it occasions a considerable reduction in mileage costs—from 10 to 15 per cent. These figures, although not as accurate and comprehensive as could be desired, yet are significant of the general all around commercial efficiency of the system as installed.

In conclusion, a review of the results achieved at Warren cannot help but impress one with the fact that numerous predictions of failure of gas power in railway service are not based upon experience with modern high grade equipment, and the author will consider himself fully repaid for the work of preparing this paper if he shall have succeeded in bringing home to you this one fact. The most casual reader of technical literature cannot help but be impressed with the extent of the gas power work going on abroad, and it is high time that power users were brought to a realization of the resourcefulness of American engineers. The city of Johannesburg, South Africa, is installing an 8,000 kilowatt producer gas engine station which will operate the entire light, power and traction system of the city. A similar equipment is nearing completion at Madrid, Spain. In view of recent American engineering progress the reasons are not apparent why this country should not at least follow the lead, if not set the pace.

THE FUEL ITEM AND REAL ECONOMY.

A recent number of "Power" notes that engineers have come to recognize that the engine which uses the least amount of steam or the plant which uses the least coal is not necessarily the most economical plant to put down. The ultimate cost of running a plant must include attendance, depreciation, interest, insurance, taxes, etc., as well as fuel, and the fuel item is for the ordinary case not more than 50 per cent of the total, and may be 30 or less. If the fuel item is cut in two by an investment which doubles the standing charges, the ultimate result is likely to show on the wrong side of the ledger. This, as we started by saying, has come to be well recognized, and we see less striving after record steam consumptions without regard to the cost of attaining them. There is another factor, however, which, always present and potent in the mind of the man with his hand on the purse strings, is not sufficiently considered by the engineer.

Fuel	$10.00	$ 6.00
Attendance	2.00	2.50
Supplies and repairs	1.00	1.50
Fixed charges	5.00	8.00
Annual cost per horsepower	$18.00	$18.00

Suppose a man who has a plant, the performance of which is represented by the first column of figures, yields to the representations of the advocates of greater efficiency and puts in modifications which reduce the fuel item 40 per cent, but raise the other items correspondingly. If the business persists and succeeds, if the plant is run for the estimated number of hours at the estimated capacity, if the depreciation has been so wisely fixed that the plant at any time could be sold for its cost, less the allowed depreciation, then the investor would be just as well off in the one case as in the other. But suppose an interruption to or a failure of the business; or suppose, however successful the business may be, that the owner wants to get out—then the less he has invested in it, the more nearly foot-loose he is, the better he is off. If the interruption is extended, or even if the output is considerably reduced over an extended period, the standing charges become an exorbitant proportion of the total. If the plant must be broken up, the depreciation will be enormous. Much of the cost which went into foundations, labor of erection, etc., will not appear in the selling value of the machinery, piping, etc., much of which, a first-class asset to the active concern at its market price installed, would be not much better than junk thrown onto the market. A machine becomes second-hand after it has been set up and run for ever so short a time; and did you ever try to sell a second-hand machine?

The difference between the first and the second cases must be sufficient to cover, in the mind of the investor, these exigencies and possibilities. He would rather have the money in the bank, where he can get at it when he wants it, than invested in a venture which may net him 10 per cent annually if the business lasts long enough to use up the plant for which the money is spent.

HARVARD MEDICAL SCHOOL.

This week the new and magnificent buildings of the Harvard Medical School were dedicated. They stand on the Fenway, and cost $5,000,000. This group is the largest addition, in its history, to the resources of the university, and will take care, it is said, of 600 enrolled students. The electrical equipment will go far to illustrate the use of electricity as a new adjunct in medicine and surgery, and the Roentgen ray outfit will be unusually complete, including provision for ray photography.

NOISELESS EXHAUST.

The gas engine is not the only offender in the matter of noisy exhaust. Muffling tanks to minimize the noise of the escape of exhaust steam from high-pressure non-condensing steam engines are sometimes needed. In such cases it suffices to insert near the engine a tank of 15 or 20 times the volume of the cylinder and continue the exhaust pipe from this muffler. This will do away with the disturbance caused by high-pressure exhaust steam passing through a tortuous exhaust pipe.

STEPS OF TROLLEY CARS.

A recent number of the "Electrical World" says that the New York State Board of Railroad Commissioners have received many complaints from women in reference to the excessive height of the car steps on the street surface roads in that State. It was decided by the Commission that a remedy could be more quickly obtained by a conference with the managers of the different roads than by recommendations to individual companies against whom the complaints have been received. For this reason the matter was brought to the attention of the New York State Street Railway Association, which at its last convention appointed a committee to consider the subject. This committee has reported to the Association that the preferable maximum height between the top of the rail and the first step of all cars of the box type with 33-inch wheel is 18 inches, with a minimum height of 14; that the maximum distance between the first step and the car platform be 15 inches, with a minimum distance of 12; and that the maximum distance between the car platform and the top of the floor of the car be 10 inches, with a minimum distance of 8. "It is the opinion of the committee that an ideal condition would call for a height of 17 inches from top of rail to the first step, and from the first step to the platform, 14 inches, and from the platform to the floor of car, 10 inches, making a total distance from top of rail to floor of car, 41 inches. It is also recommended that the tread of all steps be not less than 10 inches."

CARBONIC OXIDE POISONING.

The British Home Office issued on May 30 a four-page circular written by Dr. B. A. Whitelegge upon the use of water gas and other gases in factories, referring particularly to industrial gas and producer gas. In seven years there had been 108 cases of carbonic oxide poisoning about manufacturing plants, 35 of which were fatal. The treatment is briefly, fresh air, artificial respiration, administering of oxygen and application of warmth. The following are given as

PREVENTIVE MEASURES.

1. Notices should be posted up stating the deadly nature of the gas, the symptoms produced by its inhalation and the best means of rendering aid to those who are "gassed."

2. Persons in charge of any engine worked by the gas, or of any apparatus in which it is stored, or otherwise exposed to risk of inhaling carbonic oxide, should be free from any disease of the heart or lungs. Employers would do well to cause such persons to be examined and certified by a medical man.

3. No person should be allowed single-handed to execute work in places where exposure to the gas is to be anticipated.

4. No engine in which the gas is used should be in a confined space.

5. A competent and responsible person should, at stated short intervals, inspect all valves and connections, to see there is no escape of gas, and a signed record with the dates of such inspection should be kept.

6. The openings giving access to any part of the gas circuit should be few and in position as safe as possible, and opened only in cases of real need and by responsible persons.

7. No workmen should enter, or approach when opened, the holder or other part of the gas circuit until the gas has been well flushed out by fresh air.

8. A cylinder of compressed oxygen, fitted with a piece of rubber gas tubing and a mouthpiece, should be kept in constant readiness. Such cylinders can be obtained fitted also with a reducing valve.

9. Medical aid should be summoned immediately, but in view of the importance of losing no time in commencing treatment, the workmen employed should be instructed by a medical man in the manner of administering the oxygen and of performing artificial respiration. They should be especially warned of the danger of exposing the patient to cold.

The following notice has been compiled by the Power Gas Corporation which operate the large Mond producer gas plant, and may serve in similar situations as a

MODEL NOTICE.

Danger of Gassing.—Breathing of producer gas should be avoided. It is dangerous when breathed in quantity.

The first symptoms produced by breathing the gas are giddiness, weakness in the legs and palpitation of the heart.

If a man feels these symptoms, he should at once move into fresh warm air, when, in slight cases, they will quickly disappear.

Exposure to cold should be avoided, as it aggravates the symptoms.

A man should not walk home too soon after recovery, as muscular exertion after exposure to the gas is to be avoided.

If a man should be found insensible or seriously ill from the gas, he should at once be removed into fresh warm air, and immediate information be sent to the oxygen administrator, a medical man being sent for at the same time.

No man should work alone on any work which would be likely to involve exposure to the gas. Should the nature of the work cause the man to enter a culvert or hole, he should have a rope tied securely round his waist, held at the other end by his mate, standing outside.

Oxygen Cylinder.—The cylinder should be provided with a lever key, nipple and union, together with a rubber tube at the end of which is a mouthpiece. It is also advisable to have a small pressure gauge attached to the cylinder, so that loss of oxygen may be observed and the cylinder kept in working order.

Open the valve gradually by tapping the lever key (fully extended) with the wrist until the oxygen flows in a gentle steam from the mouthpiece in the patient's mouth and allow the oxygen to be breathed until relief is obtained. The lips should not be closed round the mouthpiece, as it is important to allow free egress for surplus oxygen. The nostrils should be closed during inspiration or inflation of the lungs and opened during expiration or deflation of the lungs, so that the oxygen may be inhaled as pure as possible through the mouth.

If the teeth are set, close the lips and one nostril. Let the conical end of the mouthpiece slightly enter the other nostril during inspiration and remove it for expiration.

Artificial Respiration.—Artificial respiration is sometimes necessary in addition to the oxygen inhalation, if the oxygen does not appear to act quickly.

Place the patient on his back, slightly raising the shoulders with a folded coat; remove everything tight about the chest and neck; draw the tongue forward and maintain it in that position. Grasp the arms just above the elbows and draw them steadily above the head, keeping them on the stretch for two seconds and then folding them and pressing them against the chest for the same length of time. Repeat these movements about 15 times a minute for at least half an hour, or until natural breathing has been initiated, when the oxygen inhalation alone will suffice.

After recovery, oxygen inhalation at intervals should be continued as desired.

CRUDE OIL.

Crude oil, according to the results of recent experiments, has a fuel value per pound equal to that of 2.785 pounds of California coal. The oil weighs 7.6 pounds per gallon, so that 94½ gallons equal a ton of the coal specified.

WELSH ENTERPRISE.

The waters of Lakes Lyddaw and Glaslyn, in Wales, are to be used to generate electric power for the Welsh slate quarrying industry. An effective head of 1,100 feet is available.

Oil engines are now used in numbers in Palestine for pumping water from wells. The first attempt at introducing the engines there for that purpose is said to have been made about three years ago by a German firm, the engines being small ones of three or four horsepower. At first no one would try them, but finally the agent of the firm in question volunteered in one case to set up an engine free of expense by way of experiment, and this little installation worked so well that it quickly led to the placing of several orders for more. Since then about sixty oil engines have been set up in different places, practically all for plantation work, about two-thirds of the engines having come from Germany and the others from British makers.

INK.

It is claimed that the particles of India ink when examined under a powerful miscroscope are found to be moving about with immense activity, and this movement, which is characteristic of inks in general, is said to be the reason why true inks do not settle. The addition of certain salts, however, stops the rapid motion, whereupon the particles group themselves together and descend to the bottom in precipitate form.

ACETYLENE VS. COAL GAS OR ELECTRICITY.

In a recent number of "The Electrical Review" Mr. Horace Allen has the following to say about the demerits of acetylene for lighting:

"Though the demand for acetylene gas has steadily and continually increased ever since calcic carbide became a commercial commodity less than fourteen years ago, through the development of the electric furnace, it is doubtful whether it will ever seriously enter into competition with either coal gas or electricity in the field of general and economical illumination for public or domestic purposes, or for power development, on account of the high cost of calcic carbide. So long as electricity is employed in its manufacture, the possibilities in the way of the price ever coming within the range of competition are very remote. Added to the cost of manufacture, there is necessitated the expense of packing in hermetically sealed drums and tin canisters, owing to the great affinity of calcic carbide for moisture.

"Pure acetylene gas is credited with having a faint, sweet smell, but the smell given off by all the carbide the writer has had the opportunity of examining has been quite the reverse of either faint or sweet.

"The unpleasant odor arising from raw carbide upon opening the receptacle is a primary source of objection, and any neglect in the way of resealing the drum after the withdrawal of the required quantity, results in the continued gradual generation of acetylene and its objectionable smell. For this reason the best place to store carbide is at some considerable distance from any occupied building.

"Various methods have been applied to overcome this serious drawback in the way of coating the carbide, and by counteracting the smell by the application of strong, sweeter smelling essences. However, such treatment has chiefly been confined to small retail parcels, for which a higher price has to be charged to cover the additional treatment.

"The method of dipping the carbide into petroleum, and then into glucose, resulted in a material that was almost entirely protected from the atmosphere and free from any objectionable odor, besides having the further advantage of being much more slowly acted upon by water.

"However, even this treatment does not entirely remove the tendency to continue the evolution of acetylene gas after the consumption has ceased, a very serious source of trouble in all generators using raw, or untreated, carbide. Another feature in connection with the action of carbide and water in the generation of acetylene is the amount of heat given off in the reaction.

"One pound of carbide, when brought into contact with water, gives off in its decomposition 753 B. TH. U., which, in the absence of an excess of water, is sufficient to raise the temperature of the surrounding materials to a bright red heat. On this account, all apparatus for the generation of acetylene which is not provided with a sufficient quantity of water to insure the dissipation of the heat evolved, is liable to become heated to a dangerous point in case of too rapid a consumption of gas. When this happens, the acetylene becomes decomposed, as is evident by the black material in the residual lime.

"To a certain extent, calcic carbide resembles the electric accumulator or storage battery, for while by present processes it requires the expenditure of from 2.0 to 2.3 horsepower-hours to produce one pound of carbide, this may be conveyed to any distance, or stored for any length of time, if properly protected, and then the acetylene generated from it is capable of developing 1 horsepower for one hour if used for driving a gas engine; this, by the way, is not a demerit, but the reverse.

"By virtue of this property it can be used to transfer energy from waterfalls in distant situations to localities where it could be turned to useful account.

"The residual lime remaining from the decomposition of calcic carbide in the generation of acetylene has a very unpleasant smell when first brought out of the generator—so much so that, in the case of small apparatus, it is offensive if brought anywhere near inhabited rooms. The sludge settles down into a more or less solid mass if left to accumulate, and is somewhat difficult of removal, though it is claimed that when the carbide has been coated with glucose the lime is chiefly rendered soluble; this claim is generally more theoretical than actual, owing to the small proportion of glucose employed.

"To turn our attention now to acetylene, there is no doubt that the light is of high quality, both in regard to illuminating power and its preserving the natural colors of materials, etc.

"A drawback which has given considerable trouble is the necessity for a very fine orifice in the burner; it took a considerable period of time for the devising of a suitable burner, but even now, while the jet is of such small dimensions, it is liable to be stopped by the slightest particle of dust, or, on the other hand, carbon becomes deposited and a heavy smoky flame results.

"To prevent the deposit of carbon at the orifice of issue from burners, a very common source of trouble, the device of providing duplicate orifices at such an angle that the two issuing jets are made to impinge upon each other and form a clear flat flame, was claimed to be successful.

"This class of burner found much favor as an improvement over the single jet, but it not infrequently happens that some slight particle of dust lodges in one of the jets, and deflects the flow of gas to such an extent as to prevent the two jets meeting centrally; the result is a very unsatisfactory flame, which can only be rectified by inserting a fine needle or wire into the clogged orifice. This would seem to be a very simple matter, but it must be borne in mind that the burner goes wrong just when the light is required, and it is necessary for the acetylene gas tap to be closed and some other light obtained to enable the clearing of the burner to be effected, owing to the minuteness of the hole in the burner and its angular direction; to insert the wire in the orifice in most burners is quite on a par with threading a needle with the eye in a rather inaccessible position.

"Some burners have the orifices in such a position as to render it a very delicate matter to clear them on their becoming clogged, but the simplest way to overcome the trouble is to provide spare burners, it being an easier matter to change the burner than to probe it in situ.

"While ordinary coal gas, in course of time, reduces leakage, through deposit, this is not the case with acetylene, so that all joints must be thoroughly sound from the first.

"In regard to leakage, the unpleasant distinctive odor of impure acetylene had the advantage of quickly indicating the existence of a leak and its locality. When the gas is purified properly there is less evidence, and therefore greater danger from this source of trouble.

"Owing to its high specific gravity, 0.9, or twice that of coal gas, it does not so readily diffuse and pass away; and although the smallness of the jets renders the volume passing out in a given time considerably less than in the case of a coal gas burner, though it must be borne in mind that the pressure is usually about twice that required for coal gas, the escaping gas hangs round and tends to form an explosive mixture which would do considerable damage if even a soldering bit or glowing cigarette should be brought near, the ignition point being only 896 degrees Fahrenheit, while so small a proportion of acetylene as 3.5 per cent forms an explosive compound with air, as compared with 6 per cent with coal gas.

"It is claimed for acetylene that its vitiating effects are only about one-eighth those of coal gas flame, and that its heating property is very slight, but it must be remembered that the heat given off by an ordinary gas flame or incandescent burner has a great ventilating effect, so that the impurities given off will also be carried away as long as there is an outlet."

ILLUMINATING POWER AND LIGHTING EFFICIENCY.*

(By W. R. Herring.)

During the past six years I have had occasion to devote very considerable time to investigating the phenomena which go to make up the efficiency of the light emitted by an incandescent burner, and have been directing an investigation into the causes which enable gases of various luminous flame values to render the same illuminating power when burned in the incandescent burner. I have had the opportunity of dealing with many grades of gas ranging from 12 to upwards of 30 candle-power.

It is generally believed that calorific power alone is to be the governing factor in the future; but my investigations warrant my saying that there is at least one other important factor to be taken into account at the present day when determining the value of a gas for lighting purposes. The visible luminosity and calorific power do not alone account for the results obtained when using the gas in incandescent burners, nor can the question of flame temperature alone account for the results. I have, however, no hesitation in saying that flame volume is a factor of even greater importance than calorific power.

It will doubtless have been noticed by many—particularly with flat-flame testing—that a considerable change in the volume of flame when burning at the 5 cubic feet rate is observable without affecting the luminous value of the gas. Then again a 25-candle carburetted water gas yields a much smaller flame than a 25-candle coal and cannel gas; and yet the flame temperature of the carburetted water gas is slightly higher than that of the coal and cannel gas. If, however, the volume of flame is insufficient to properly envelop every fiber of the mantle, then neither calorific power nor flame temperature can play its part and develop the highest degree of luminosity in the mantle.

Flame volume must be dependent upon the chemical composition of the gas, which I have found can vary very considerably for gases of the same luminous value and approximately the same calorific power.

A 16-candle gas containing 3.76 per cent of the unsaturated hydrocarbons compared with an average of 27.86 candle gas containing 9.26 per cent contains two and a half times as much of the unsaturated hydrocarbons. The illuminating power is only increased by 74 per cent, whereas the increase in the percentage of the illuminants present should have yielded, in the same ratio, practically 40-candle gas, or an increase of 148 per cent. This shows conclusively that a very much lower efficiency is obtained when burning the high grade gas as a luminous flame.

Again dealing with the 15 to 16-candle series, it will be seen that there is 0.270 candle of illumination per unit per cent of hydrocarbons present in the gas; and as we advance above the 17-candle quality the percentage of hydrocarbons necessary to yield one candle of illumination increases with the increase in the flame luminosity of the gas. British thermal units are again given for this series of tests, and British thermal units per candle; the latter column again showing a loss efficiency with the high grade gas.

In carrying out these and other investigations I was often mystified by gases of comparatively low illuminating and calorific power yielding as good and sometimes better results with the incandescent burner than other gases of higher luminous value. Flame temperature naturally suggested itself as a solution of this problem, but did not satisfy me as being the only factor. I, therefore, again had recourse to our records, and prepared a statement which would show me the candle-power by incandescent burners in relation to flame luminosity and the calorific value of different gases.

From our books, therefore, we first abstracted the tests which yielded from 30 to 32 candles per cubic foot of gas when burned in the incandescent "C" burner. Against each of these results the candle-power ascertained by the argand burner is given in column No. 2, and the calorific power in column No. 3. In each case the incandescent burner was used to yield the highest efficiency, by a proper regulation of the gas and air supply. The candle-power of the gas was ascertained by a No. 1 metropolitan argand burner used to a 16 candle-power flame, and the calorific value of Junkers' calorimeter.

Incidentally, table C also confirms what I have formerly stated as to the calorific power of the gas rising and falling with its luminous value, for it will be observed that the calorific power of the highest candle gas on the list is also the highest calorific power, and likewise that the .5-candle gas is the lowest calorific power.

TABLE C.

Statement Showing Candle Efficiency by Incandescent Burner in Relation to Flame Luminosity and Calorific Value.

30.36	....	16.50	625.2
30	3.34	16.70	617.3
30.80	3.16	17.45	640.3
30.70	3.40	16.98	620.5
31	3.30	17.78	616.1
30.93	3.30	17.58	617.3
31.71	3.27	19.92	663.8
31.34	3.27	19.04	606.6
30.59	3.37	20.32	667.7
30.18	3.36	18.49	626.4
30.57	3.34	19.43	643.1
30.45	3.33	19.82	663
30.71	3.37	18.08	617.7
31.51	3.10	19.03	637.6
30.37	3.19	18.54	636.8
30.62	3.06	18.63	609.4
30.38	3.18	16.62	596.3
30.57	3.17	18.40	627.9
30.18	3.35	17.34	640.4
30.52	3.27	16.77	610.6
30.38	3.40	15.57	572.8
31.88	3.02	17.82	639.5
31.20	3.06	17.30	631.2
30.54	3.33	16.41	618.9
30.47	3.39	15.35	589.9
30.47	3.40	15.60	572.8
30.17	2.89	18.46	634.6
30.47	3.18	17.91	629.8
30.32	3.10	17.54	625.6
31.93	3.31	16.77	627.6

This statement gives some remarkable results, and goes a long way to challenge the present-day belief that calorific power alone is to be the factor governing the supply of the future. Glancing at the statement a moment, we find that a 15.35-candle gas of 590 B. Th. U. yields the same illuminating power by the incandescent burner as a 20.32-candle gas of 668 B. Th. U. A further glance at the second column will also show that gases of 15, 16, 17, 18, 19 and 20 candle-power luminous value all yielded practically the same degree of illumination per foot of gas when burned in an incandescent burner, using the same mantle with each test. Nothing could, I think, be more conclusive than this last statement as to the incorrectness of the policy of continuing to supply gas judged by its luminous flame value.

*Extract from a paper read before the North British Association of Gas Managers.

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EDITORIAL.

FIRE LOSSES IN THE UNITED STATES

During the past few years many articles have been written and published in current literature, the character of these publications covering the broadest field, such articles all dealing with the enormous losses by fire in the cities of the United States. The facts regarding the extent of such losses seem to be well established. While there have been a few very large fires, even eliminating these, the total destruction of property from the many smaller conflagrations each year aggregates a very large amount.

The Chicago fire of 1871, totaling $190,000,000 was probably the first great fire in the last decade. During the next year the Boston fire resulted in a loss of $80,000,000. Practically twenty years passed before there came the next large city holocaust. In 1901, however, Jacksonville, Fla., suffered a loss of $10,000,000. In 1902, the following year, $8,000,000 worth of property was destroyed in Patterson, N. J. Next came the Baltimore fire of 1904, the loss being $50,000,000 Finally, the greatest destruction of property up to the present time was connected with the earthquake and fire in San Francisco, April 18th to 20th of this year, the total loss, from present information, being about $250,000,000.

Summing up these losses of 1871, 1872, 1901, 1902, 1904 and 1906, the total loss for these six years aggregates nearly $500,000,000, or an average of $83,000,000 per year for the great fires only.

These figures, however, enormous as they are, do not indicate the real average fire losses in the United States. Many other conflagrations, each of much smaller extent, increase the total loss. The average from 1870 to 1880 was somewhere near $60,000,000; from 1880 to 1890 this was increased to about $100,000,000, while for the last ten years of the 19th Century, the average annual loss was about $150,000,000. Independent of the San Francisco fire, the greatest annual loss of property up to the present was for the year 1904, the amount being about $250,000,000, or an average of nearly $700,000 per day. The National Board of Fire Underwriters is authority for the statement that the total loss by fire in the United States during the past twenty-five years has reached the enormous amount of $3,500,000,000, which is an average for the quarter of a century of $140,000,000 per year.

It must be remembered that, although the individual loser may be recompensed at the time of his loss by insurance, the destruction of property by fire is always a total loss to the natural wealth of the nation. If the insurance companies do business at a profit and pay all their losses, this amount naturally comes directly from the insured, the profit of the insurance companies necessarily being an additional sum paid by the insured. This, of course, is under the assumption that the insurance is practically equal to the total loss, which, of course, is rarely the case, but under any conditions the loss is a total one.

It is stated by an authority on the subject that the fire losses now represent an annual tax upon each person in the United States of about $7.00, and the problem which must be considered is whether during the next twenty-five years this condition of affairs shall be allowed to continue.

In the largest cities of the United States, the annual number of fires has been on the increase. In England and on the Continent of Europe, the same increase in the number of fires is found in the large cities whose population is also on the increase, but the fact is that the losses in the American cities have increased much more rapidly than the growth of the cities, while the annual fire loss on the Continent of Europe is, for the large cities of equal population, or say between 200,000 and 1,000,000 inhabitants, only ten per cent of the losses in the American cities.

This is entirely due to the character of construction adopted in the older and more permanently built European cities. As an illustration of this it is said that ninety-five per cent of the fires in one of the great German cities were confined to the building in which they started. A large fire extending beyond the immediately adjoining property is almost unknown in many of the largest cities of Europe.

It is probably true that the fire fighting facilities of the fire departments in America are much superior to those of European cities, but if a fire should start in the center of many an American city, the large amount of frame buildings would cause the fire to get so beyond control as to cause a very large conflagration,

where an incipient fire would be the only result if proper construction were required.

For years insurance rates in San Francisco were quite low, due to the excellent fire department maintained by the city. One of the insurance men connected with the Underwriters, in a report made nearly two years ago, had this to say about San Francisco:

"In San Francisco, for instance, there is little being done to improve the standard of construction. It is notoriously a wooden city, yet insurance rates are fairly low, because, forsooth, the fire department is so excellent. That is like extolling the advantages of a certain locality as a health resort. It may be miasmatic; yellow fever may stalk amuck; its houses and streets may be foul, but, glory be, its doctors are skillful!"

It is undoubtedly true that the recent conflagration in San Francisco was caused primarily by the earthquake, and it is not fair to judge of the destructionn of San Francisco purely from the standpoint of the fire loss. Fortunately, a combination of earthquake and fire is rare in any country, but it is to be hoped that the average established so far for the year 1906 will not be maintained in the future. At the same time, it is undoubtedly also true that had San Francisco been built like any European city of its size, the destruction of property by fire, even accompanied by the earthquake, would have been but nominal.

It would seem, therefore, that the only way to reduce the enormous fire losses in the United States at the present time is to modify the construction of buildings so as to approach at least the conditions existing in the older European cities. This will, of course, mean an enormous additional expenditure of money for buildings, but in the end the wisdom of such construction cannot be questioned.

We have had a great deal of advice from our Eastern friends to the effect that now is San Francisco's opportunity to rebuild the city, using fireproof construction exclusively. No one can question the desirability of the new San Francisco being such a model city. Practical conditions, however, must be considered for the present at least and for a few years in the future, and unless great individual injury is done, the character of construction in San Francisco will not be seriously modified from that of the old San Francisco. It is not too much to expect, however, that the authorities will soon adopt stringent regulations which must be followed in all permanent construction in the principal wholesale and retail districts of the city.

TRADE CATALOGUES.

Bulletin "A" of the Lombard-Replogle Engineering Co., Akron, Ohio, is devoted to a brief description of that company's new water wheel governor.

The catalogue of the Wellman-Seaver-Morgan Company, Cleveland, Ohio, on "Open Hearth and Reheating Furnaces," contains many handsome illustrations which show several of these furnaces installed at various works. A description of the Forter water sealed reversing valve is included.

The Allis-Chalmers Company's type "B" direct current motors and generators are described in that company's Bulletin No. 1052. The motors are built for capacities of from 1 to 35 horsepower. The ratings of the generators range from 2½ to 25 kilowatts.

Bulletin 69 of the Crocker-Wheeler Co., Ampere, N. J., describes a type of generator, for small capacities, suitable for direct connection to steam or gas engines. These generators are built in sizes to give outputs of from 1½ to 19 kilowatts, and are especially designed for use in isolated plants and residences.

The Stanley G.-I. Electric Manufacturing Co., Pittsfield, Mass., has recently issued the following: Bulletin No. 615, which describes a flush receptacle and attaching plug; Circular No. 795, which gives some details of its 60-cycle single-phase induction motors; Circular No. 797, which describes the A. E. G. brilliant flame arc lamps; and Circular No. 798, which calls attention to the company's A. C. motors for driving laundry machinery.

The construction and some of the particular adaptations of the Northern spherical motors for driving machinery in shop and factory are excellently shown in Bulletin No. 50A of the Northern Electrical Manufacturing Co., Madison, Wis. This bulletin is highly illustrated, and shows not only motors and generators of the horizontal type, but also back-geared, vertical and universal motors.

PERSONAL.

Rufus P. Jennings, Chairman of the California Promotion Committee, has just returned from a five weeks' visit to the East. Mr. Jennings expressed himself as very much impressed with the interest which Eastern people are taking in California. Much of this is no doubt due to the effective work of the Eastern Bureau of the Committee, which has its headquarters opposite the Flat-Iron Building in New York.

Spokane, Wash.—Graham B. Dennis, who built the first electric railway in the Northwest in Spokane in 1887, and who has since been identified with development projects, commercially and industrially, has just been elected president of the Pacific Northwest Development League, which will exploit the resources of Washington, Oregon, Idaho, and Montana. The League will have a fund of $100,000 to be used in a campaign for population and commerce in the quartet of States.

Mr. Dennis is a pioneer of the Northwest, coming to Spokane twenty-two years ago from Dayton, Ohio, and his identification with Spokane and its commercial interests and the development of the State of Washington are parts of their history. As chairman of the Publicity Committee of the Spokane Chamber of Commerce he attracted millions of Eastern capital to this part of the country, and he has been the means of interesting prominent men in the East and Middle West in electric railway construction and power plants, giving the various cities and towns in Eastern Washington a service which would do credit to much more closely populated territory.

The Pratt Institute Free Library, Brooklyn, N. Y., has published a 33-page pamphlet giving reference to good books on electricity. The information includes the title of the book, the names of author and publisher, and the price, besides brief comments on the subject matter. A copy will be sent by the Institute to any address on receipt of a request.

An announcement from the Electrical Trades Exposition Company states that permanent headquarters have been opened at 1006 and 1007 Monadnock Block, Chicago. Under its management, the second annual electrical show will be held at the Coliseum, Chicago, from January 14th to January 26th, 1907.

SAFEGUARDS AGAINST FIRE*

Good fire protection necessitates first, that the least amount of combustible material should be used in constructing a building; second, that the construction should be such that it would tend to limit a fire to the place of origin; third, that the furnishings should be so arranged that the possibilities for fire are reduced to a minimum; and, fourth, that means for the ready extinguishment of a fire should be provided at well chosen places. Underwriters' boards and associations substantially recognize the importance of these precautions, but property owners do not always give them the consideration which they deserve.

For economical and other reasons, the work of the fire protection engineer should be done conjointly with that of the architect and the structural engineer. Proper consideration for the possibility of fire at the time of preparing building plans not only means a large saving in the cost of installing private fire protection apparatus, but also permits of its arrangement so as to be most effective.

A bucket of water or of chemical solution, if intelligently used, is nearly always sufficient to put out a fire if readily available near the incipient blaze. But a bucket of water is not always handy, and frequently there is on one near to use it; consequently, good fire protection must necessarily depend upon distributed automatic devices. The usefulness of the automatic sprinkler is pretty generally recognized by property owners and underwriters. It is worthy of note that the rates of insurance on Class C buildings equipped with these are lower than on Class A buildings, without them.

Sprinklers are not intended to check conflagrations, but to extinguish or control fires in their incipiency. In a properly installed sprinkler system, the presence of fire is made known by the striking of a mechanical alarm which is operated by a water motor set in motion by the opening of one or more fusible heads. The electric alarm is uncertain of operation and should be installed only as auxiliary to the mechanical alarm. A very complete alarm system may be seen at the Pacific Hardware & Steel Co.'s building in San Francisco. Not only are the mechanical alarms set in operation, but drop annunciators indicate the section of building, the story, and the portion of floor where the head is discharging.

Inside stand pipes with hose constantly attached, and approved chemical extinguishers are of great value in augmenting protection afforded by automatic sprinklers.

Ridge, cornice and window sprinklers are efficient in lessening the danger from exterior fires. While metal-clad wooden frames containing ordinary glass are poor apologies for fire proofing, properly constructed metal frames fitted with wire glass and used in conjunction with window sprinklers connected to proper water supplies, are equal if not better than any shutter manufactured. The latter soon deteriorate from weather and lack of attention, and are rarely closed when they should be. Roof tanks of gravity flow, except as secondary supplies to sprinkler systems, are practically useless for fire purposes when the discharge is less than fifty feet below the tank bottoms.

Basement reservoirs with flexible and non-deteriorating linings and flowing wells, both of sufficient capacity and furnishing suction for steam or gasoline-driven pumps, are the solution of perfect private water supplies in sections susceptible to siesmic disturbances. This point is borne out by the operation of pumping plants at the Palace Hotel, Merchants' Exchange, Western Electric Co., and Center's Wells after the earthquake of April 18th. The building of the Western Electric Company was saved from destruction more through the private water supply than by its wire-glass windows. Electrically-driven pumps are impracticable on account of uncertainty in the supply of current.

Fire is a chance occurrence which breaks out without any warning; hence, fire fighting apparatus should be as self-sustaining as possible, as well as fool-proof.

* Abstracted from an address delivered before the Structural Association on September 6, 1906, by Mr. George J. Wellington, Fire Protective Engineer.

ELECTRICALLY OPERATED HATCHES.

The London "Electrical Engineer" notes that the United States naval authorities are responsible for an interesting development in the introduction of electricity to naval matters. It is well known that armour hatches have been a problem ever since the protective deck was introduced, and to supersede the block and tackle which has been used in the past for raising and lowering the hatch plate quickly and safely under all conditions, the "long-arm" electrically-operated hatch gear has been introduced. An important feature of this device is the locking mechanism, which consists of a number of bars all connected to one shaft across the center of the plate, and so arranged that when the shaft is rotated the bars are forced out beneath the deck and draw the hatch plate firmly down to its seat. The mechanism is actuated by the lift, and does not require separate manipulation. When the hatch is closed and locked, and the operator starts to open either by hand or power, the lift first unlocks the plate, after which it opens to any desired extent. A mechanically-operated stop prevents the locking gear from throwing out the bars except when the hatch plate is completely closed. The motor and controller of the hatch lift are connected with a central emergency station located above deck, and form a part of the system by which the main bulkhead doors of United States warships are controlled from the central station. The "long-arm" hatch gear offers practically three methods of operation—at the hatch, both above and below deck, by power which is brought into action by means of the controller handle; above and below deck, by means of the hand gear intended for use in case the electric power should fail; and from the emergency station on the bridge, by means of which the closing of all power-operated hatches on the ship is always instantly possible.

The death of Mr. John R. Bowie, of the engineering and contracting firm of Pepper & Bowie, has necessitated the dissolution of partnership. The surviving partner, Mr. David Pepper, Jr., will himself carry on the business of engineering and general contracting, and has established offices at 1233 Land Title and Trust Building, Philadelphia, Pa.

GAS HOLDER.

The largest gas holder in the country and possibly in the world is said to be that under construction at the Astoria works of the Consolidated Gas Co. of New York. It is 300 feet in diameter and will rise to a height of 260 feet when fully inflated. Its capacaity will be 15,000,000 cubic feet.

The A. Lietz Co., manufacturers of surveying and nautical instruments, have returned to their old location, 632-4 Commercial street, between Montgomery and Kearny streets.

LARGEST MOVABLE DAM OF BEARTRAP TYPE IN THE COUNTRY.

(By W. C. Weeks, Superintendent of Construction for the Washington Water Power Co. of Spokane.)

The installation of a beartrap gate, or, more properly speaking, a movable dam of the beartrap type, at the north channel controlling works of the extensive power development by the Washington Water Power Co. at Post Falls, Idaho, on the Spokane river, has awakened considerable interest and speculation as to the manner of its construction and operation, as well as its history and development to its present stage of perfection.

As far as is known to me, the beartrap dam at Post Falls is the only one of its kind in the Inland Empire, and a brief description and history of this gate and its prototype may be of interest to those connected with the various power development enterprises in the Northwest, as well as to those who take a general interest in things out of the ordinary.

The design and construction of means for controlling the flow of water in sluices, flumes and locks has been given very close and detailed study by European engineers for many years, and it may here be noted with satisfaction that the beartrap type of movable dam is distinctly an American invention, and, strange to say, was the direct result of the necessity of obtaining a supply of anthracite coal to operate a wire mill in 1818.

No gate or dam heretofore constructed was suitable to the purpose, so Josiah White devoted his talents to constructing a movable dam which could be made to impound water in a pool, and then fold up or collapse sufficiently to allow coal barges to pass over it with the rush of water. He devised such a dam, and in order to demonstrate its practical working, had a small gate built in an experimental sluice in Mauch Chunk creek. Curious persons were evasively answered by the workmen that they were building a bear trap, and this form of dam has retained the name of "beartrap" ever since. A number of dams were built in the river, supplied with beartrap gates, and their use was so successful that they became of great importance in hydraulic development.

The first beartrap dam consisted of two flat, rectangular leaves. These leaves having a width of a certain ratio to each other, and a length equal to the width of the sluice they were to control. The total rise of the dam is limited by means of a number of chains fastened to the under side of the lower leaf, which coil up on the bottom of the chamber when the gate is down. The successful operation of the device depends upon an unbalanced hydrostatic pressure on the leaves of the gate when the pressure of the water above the dam is admitted to the chamber beneath.

With the development of navigation in the United States came a further study of beartraps. A man of prominence, Ashbel Welch, came out boldly with his approval of the type, and we hear of a board of United States engineers recommending the adoption of the beartrap for a dam at Beattyville, on the Kentucky river, in 1886.

Naturally a number of improvements were proposed, some of which were variations, others alterations, and some having distinct merit. The development may be readily traced from the original beartrap to the design recognized as having unusual merit, that of being readily proportioned to all heights of backwater. Passing over some unimportant and grotesque modifications, we come to Girard's French patent, in which the lower leaf was hinged near the middle.

This was a new idea of genuine merit, but the French engineers failed to appreciate its merits, and it remained for Thomas Parker of Menominee, Wis., to improve upon Girard's patent by reversing the gate, pulling the folding leaf up stream, and protecting the gate against destruction by an upstream leaf. Were it not for this leaf, debris would sooner or later jam between the upper leaves and wreck the gate. Next we note Lang's improved gate, in which one of the leaves of the Parker gate is replaced by a tie and the upstream protecting leaf shortened. Several dams of the Parker and Lang types of beartrap have been constructed in the Middle West, all of which are giving satisfaction. They find particular favor with lumbermen in the improvement of streams for driving logs, and this fact has extended their use.

Next we come to the reversed Parker, a form proposed and patented by Capt. A. C. Powell, now chief engineer of the Lake Washington ship canal, and Archibald Johnson, in 1896, both these gentlemen being at that time engineers in the United States engineer office, St. Paul. Several of these have been constructed and are in successful operation. It is particularly sensitive to difference in elevation of head and tail water, that installed at Lake Winnibigoshish dam to Northern Minnesota rising with a head of but two inches.

The beartrap at Post Falls is of the reversed Parker type. The entire controlling works at the north channel, including the beartrap, was designed by the patentee of the reversed Parker beartrap. It was completed just before high water this spring, but because of freshly placed concrete in the foundation no attempt was made to operate the gate until the flood had partly subsided. It was then found that the gate would not rise, owing to the excessive weight upon the idler or downstream leaf. This leaf was accordingly removed, the location of this gate being such that the idler was not essential, and since that time the beartrap has worked in a satisfactory manner, responding perfectly to the operation of the controlling valves.

Though there are several larger, the beartrap at Post Falls is one of the large beartraps, and probably the largest ever constructed of its type. It closes an opening 110 feet wide, and in common with the working of all dams of the beartrap type, is operated with ease by one person. This is one of the features of this class—the ease and simplicity of operation. The beartrap in the Chicago drainage canal spans an opening 160 feet wide; one was built in the Monongahela river 120 feet wide, and there are doubtless others closing passes in excess of 100 feet. The object of the beartrap at Post Falls is to provide an easily controlled opening for the passage of an immense volume of water laden with debris and drift.

By its installation provision has been made to pass, without raising the river in the least above its natural level, all the water, and more, that ever came in the highest known high water. In other words, the beartrap type of movable dam, in conjunction with the Tainter gates, has enabled the controlling works at the north channel to be so constructed that the entire development of the Washington Water Power Co. at Post Falls has resulted in increased facilities for the passage of flood waters over that afforded by the river in its primitive condition.

SWEATING OF PIPES.

Insulating cold water pipes is frequently done in sections of the country where the water flowing through the pipes is at a comparatively low temperature, the warm air passing over them cooling so quickly as to cause condensation of the moisture in the air. The wet spots under the water pipes are frequently attributed to leaks, but the experienced plumber diagnoses the case as one of sweating. The remedy is to cover the pipes with some kind of non-conducting covering like some of the asbestos productions, protecting the pipes from the warm air.

PRICE OF ILLUMINATING GAS IN ENGLAND.

Consul F. W. Mahin reports that the price of illuminating gas in Widnes, Lancashire, England, is now 32 cents to small consumers, but will be reduced to 30 cents on July 1. Large consumers will pay from 22 to 26 cents. This is claimed to be the cheapest gas in the world. The town has about 30,000 population. The price of gas is remarkably low everywhere in Great Britain, whether under public or private control, the general range of price being 40 and 70 cents.

INDUSTRIAL

YOU CAN'T KEEP A GOOD FIRM DOWN.

At the time of the big fire, April 18th, the Electric Appliance Co., like nearly everybody else, lost their entire stock. Immediately another complete stock was rushed to the Coast, which coming through promptly enabled them to take care of their large and increasing trade so well that many of their customers hardly realized that there had been a fire. On last Wednesday evening, six months after the big fire, they received another scorching, and while the loss was considerable, it only affected a few items, which were easily and quickly replaced. Already the Electric Appliance Co. are filling all orders, as usual, and are still able to make good their claim that no house on the Coast shall ever excel them in promptness, or the quality of material furnished.

One of the largest independent switchboard and central equipment contracts ever let has been awarded to the Dean Electric Co., Elyria, Ohio, by the Detroit Home Telephone Co., Detroit, Mich. This contract calls for the manufacture and installation of a complete exchange equipment for the main, east, west and north exchanges, besides 8,000 telephones in the initial order.

The main exchange to consist of 27 sections common battery multiple, a board equipped with 8,000 lines, multiple line and relay equipment; 9,600 answering jacks, besides seven (7) trunking sections, chief operator's desk, four (4) position observation desk, four (4) position monitor's desk, three (3) position wire chief's and a two (2) position manager's desk; main and intermediate cords connecting relay racks, duplicate charging machines, duplicate sets storage battery.

East exchange, 1,300 line, three (3) incoming trunk sections, chief operator's, monitor's and wire chief's desk, main and intermediate relay racks, duplicate charging machines and duplicate sets storage battery.

West exchange, equipped for 800 local lines, three (3) incoming trunk sections fully equipped, chief operator's monitor's and wire chief's desks, main and intermediate relay rack, duplicate charging machines, duplicate sets storage battery.

North exchange, equipped for 2,400 lines, three (3) incoming trunk sections, chief operator's, monitor's and wire chief's desks, main and intermediate relay racks, duplicate charging machines and duplicate sets storage battery.

All the switchboards include the Dean individual indicating 4-party ringing keys and wired complete for the Dean harmonic selective party line system, metal lamp jacks and spring metal lamp caps.

Each position will be provided with test cords and keys for testing lines and supervisory relays and cords.

In addition to the above contracts, the following have also been received:

Common battery multiple: Canton, N. Y.; Odessa, Mo.; Moorefield, Ohio; Benzonia, Mich.; Culpepper, Va.; Carbondale, Pa.; Mentor, Ohio; Charleston, W. Va.; Urbana, Ill.; Portland, Ore.

ALLIS-CHALMERS STEAM AND ELECTRICAL UNITS FOR OXNARD, CAL.

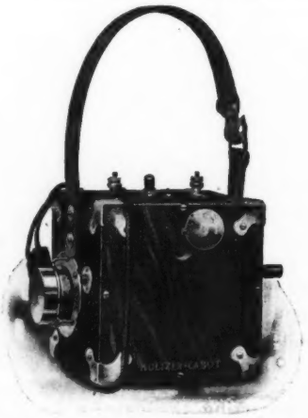
The Ventura County Power Co. of Ventura, Cal., will install a new power station at Oxnard, the equipment for which has recently been contracted for with the Allis-Chalmers Co. of Milwaukee.

The outfit will comprise a standard 300 kilowatt Allis-Chalmers engine type generator, designed to operate at 125 revolutions per minute, 50 cycles, 3-phase and 2,300 volts. The generator will be separately excited and will be driven by a Reynolds Corliss tandem compound condensing engine of the heavy duty type, 16x32x36 inches, and operating at a speed of 125 revolutions per minute. The engine is to be fitted with a complete electric synchronizing device and will have valves in the heads of both cylinders.

LINEMEN'S PORTABLE TELEPHONE TESTING SETS.

The Holtzer-Cabot Electric Co. of Brookline, Mass. and Chicago, Ill., have recently developed and placed upon the market two new types of portable testing sets for linemen's use. These are known as the "Universal," and "Watchcase Receiver" types, description of which is given in the following:

The Universal type of testing set was designed to meet the practical requirements of telephone linemen, and contains many novel features which should commend themselves to users of this class of apparatus. It embodies everything required in all classes of telephone line testing, thereby doing away with the necessity of having separate sets for series and bridging work. The case, which is substantially made and protected by metallic corner shields, is provided with a carrying strap which has a snap catch so that the box can be quickly suspended from the cross-arm or any projection by the use of one hand. The door is held closed by an automatic catch which is released by a flush push button preventing the case from being accidentally opened. This set is



provided with a hand microtelephone which combines the Holtzer-Cabot bi-polar watchcase receiver and standard granular carbon transmitter. This instrument enables the lineman to talk with ease in any position that he may be, as it may be taken from the box and the door closed. This feature has

great advantages over the testing sets in which the transmitters are mounted on the cover. The mouthpiece is metallic so that it will withstand hard usage, and in the handle there is a push button which throws the batteries out of circuit when not in use, thus prolonging their life. Three or four bar generators of the magneto type are furnished as desired. They give alternating current for signaling subscribers, or pulsating direct current for ringing the switchboard; this is controlled by a two-point switch inside the cover. There is also a push button to shunt out the ringer on heavily loaded lines. Each set is equipped with standard 1,000 ohm ringer, which may be shunted out of circuit when desired by means of the push button. The induction coil is of the standard square head type, with a resistance of 100 ohms. Two dry batteries are used which are of long life by reason of the precautions taken to minimize the current used. The binding posts are conveniently located on the top of the case, and may be manipulated by one hand without a screwdriver or tool of any kind. Aside from being the most efficient and compact testing set on the market, the Universal is a complete portable telephone, having all high grade apparatus. It can be used to excellent advantage on isolated steam and electric railroad lines for communicating with terminals or branch stations.

For certain classes of testing, sets of the receiver type have become popular with linemen, and on account of several practical features which are embodied in the latest model placed on the market by the above company, that do not appear in other sets, an increase in the demand for this article is anticipated. The essential features of this set correspond closely to the Universal type above described. The case has protected corners and a carrying strap furnished with a clasp so that the box may be quickly suspended. The receiver is of the watchcase, bi-polar pattern, and is used for both talking and listening. A valuable and essential improvement is the addition of a push button in the receiver. This button normally keeps the receiver circuit open, but upon pressing it the circuit is closed. Thus, while communication is established, the button is held closed by the thumb of the operator, but as soon as the conversation is through the receiver may be laid down and the circuit is automatically opened. This feature is greatly advantageous over other methods used, as in other types the receiver is frequently allowed to remain in the circuit; this is liable to demagnetize the permanent magnets in the receiver and render it useless. The receiver is wound to 150 ohms, and is enclosed in a metal case, making it a substantial instrument for outdoor use. The generator is equipped with combination spring and two-point controlling switch enabling it to give alternating or pulsating direct current for signaling the subscribers or the central switchboard. The resistance of the ringer is 1,000 ohms, and may be shunted if desired when used on a heavily loaded line. This set has been carefully designed, and meets the various requirements of line testing where the more elaborate set is not necessary. It is equally serviceable on both series and bridging circuits.

Moisture in the cylinder of a gas engine is sometimes the cause of its refusal to start, and is one of the things that make the gas engine seem such a mystery to the uninitiated.

SUPERHEATED STEAM.

Reports from power plants carrying a steady load are very favorable to the use of superheated steam, there being little trouble experienced where the systems are well arranged. When it is attempted, however, to utilize superheated steam with conditions involving sudden and large fluctuations of load, the result is an occasional excessive rise in temperature, with constant trouble of all sorts to piping and valves. This has even caused damage in steam turbines by reason of excessive expansion of some of the parts, with resultant binding.—Exchange.

MOTOR TROUBLES.

The unsatisfactory operation of a motor is usually attributed to some defect in the armature or commutator. The "Street Railway Journal" recently notes that many overlook the fact that the fields themselves may be the cause of the trouble. If proper attention were given to the testing of fields, it is safe to say that those mysterious troubles of motors that baffle solution would be fewer in number. Frequently attempts to test fields end in failure because the work is not done properly. Often attempts are made to test them with a voltmeter and an ammeter while they are in the motor. These tests are frequently unsatisfactory because not enough current is used to get an appreciable voltmeter reading or the current is not allowed to flow a sufficient length of time to heat the fields thoroughly. A heated field will often indicate the presence of shorted coils when the same field while cool and under a drop of potential test will show up O. K. When possible, coils should be tested while clamped in position in the motor, but if this is not possible and they are tested on the floor of the shop, pressure should be put on them when the readings are taken. Sometimes standing on them or jumping up and down on them will cause a variation in the reading of the voltmeter; if so, the chances are great that the field is defective. In addition to the drop of potential method with direct current, fields may be tested when out of the motor by means of a transformer. A special transformer is required built in such a manner that the field to be tested may be slipped over a core and be made to serve as the secondary of the transformer. A short-circuited coil in the field makes itself evident by an increase in the primary current, by the heating of the field and by the sound given out from the transformer. As with direct-current tests, it is best to apply pressure to the coil in order to develop any shorts that would occur if the field were thoroughly heated and clamped in position in the motor shell.

Several field coil testing devices especially adapted for testing fields while they are clamped in the motor have also been developed within the last few years. When properly used, these devices usually give good results, and, further, the tests are made in a very short time. The machines are usually constructed on the principle of a Wheatstone bridge, a telephone or a galvanometer being employed to indicate when the known resistance is equal to the resistance of the field being tested. But in many instances where these instruments have been purchased, the shop man who is assigned to test the fields does not operate with the instrument long enough to get familiar with it. He seems to regard it as too complex to be understood. But if an earnest effort is made to test fields in this way it will not be long before satisfactory results can be secured. When the testing of fields is begun in shops in which it has not been carried on before, records of all tests should be kept and the condition of the fields when torn up should be noted. By so doing the proper resistance for a perfect coil may be obtained for each type of motor in use. When starting out, if there are no figures as to what the readings should be, the resistance of one field of the motor may be compared with that of another.

The difficulties in obtaining satisfactory results in testing field coils are no doubt largely responsible for the general inattention given them when the causes for the faulty action of a motor are being considered. But as there is such a great likelihood of the fields being the cause of motor troubles, certainly more attention should be taken to ascertain their condition whenever the trouble cannot be located elsewhere.

EFFICIENCY OF GASOLINE.

As regards the efficiency of gasoline for power generation when consumed in an internal combustion engine, or when burned under a boiler to generate steam, it is found to be about as 2 to 1 in favor of the internal combustion type.

AN IMPROVED FORM OF INLET AND OUTLET SERVICE.

CONNECTIONS.

The National Board of Fire Underwriters require that service conduit shall be continuous, and in order to meet these requirements the following arrangement (shown in Fig. 1) has been designed, developed and placed on the market:

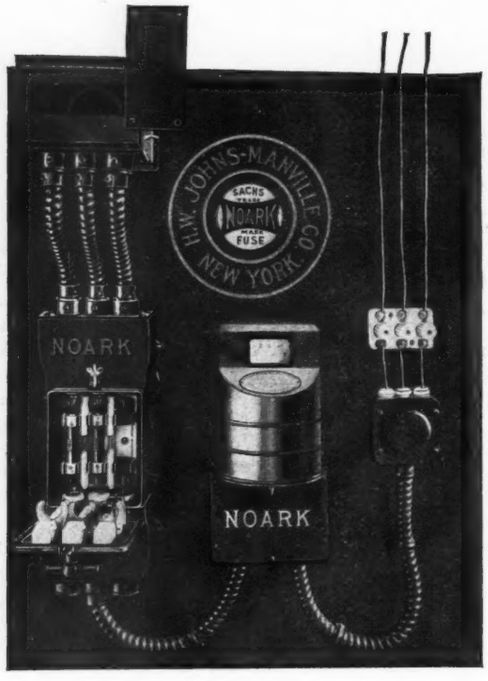


FIG. 1.

The Service Box Clamps shown in the accompanying sketch are made in four sizes, and fit over 2-inch, 2½-inch and 3-inch iron pipe and 3-inch fibre conduit. These clamps are split and bolted together in order to make a tight fit to pipe.

The Service Box is made in one piece with two openings, one in the back and the other in front. The box may be twisted so as to allow the conduit to come out from top, bottom, either side, or the front.

This Service Box may also be used on a dead end box, using the blank plates and coiling up the cable inside. A dummy plate is placed over the opening that is not used. On the other opening is placed the tube plate with three openings. If the cable to be used is large and three single conductors as for direct current, the three openings are used. If three small conductors are used, then two of the holes are filled with blank bushings.

FIG. 2

Sprague flexible conduit is used for a conduit between Service Box and "Noark" Service Switch, as shown. Bushings to take ⅜-inch, ⅝-inch, ¾-inch, and 1-inch Sprague conduits are used when cable or wire is small.

FIG. 3

The openings in the plates will take 1¼-inch Sprague conduit without bushing.

For alternating current work and when cables are over 80,000 cubic meters, an A. C. plate, as shown in Figure 2, which will take 2½-inch iron pipe, is used. If it is necessary to go up or down from Service Box, the A. C. split elbow, as shown in Figure 3, is used, and iron pipe is continued to "Noark" Service Switch.

The Sprague conduit is continued to a guard which fits over the "Noark" Switch Box, these guards being made right and left in order to go on either side of the "Noark" Service Switch Box. The ends of the guards take the same plate as the Service Box, and any combination can be effected.

From the "Noark" Service Switch Box double braided wire in Sprague conduit is used to the meter box. The meter box is made of galvanized iron with holes punched in, same to take conduit. These boxes vary in type, depending on style of meter used, and are made up to suit the conditions of the central station. From the meter box conduit continues to the cutout for the house wiring.

A number of different combinations may be made with these parts. Overhead service may be brought in direct to the "Noark" Service Switch Box. Alternating wires may be run by bringing cables or wires through one conduit, while large sized cables may be used on direct current service by employing the three openings.

If a customer is disconnected and material is removed, there is no waste, as all parts, even Sprague conduit, may be used again. This is not so in moulding work, as the greater part of the material is wasted. The time consumed by the wiremen is less in installing than that with a moulding job.

This system practically prevents the tampering with the wires between the meters and the service, as no tapping can be made without the evidence of wiring being tampered with. Any number of customers may be taken off service by use of cutouts and bus-lines. This system is in use by the Brooklyn Edison Co., of Brooklyn, N. Y., who have installed over 1,000 Services of this type.

This arrangement has been placed on the market by the H. W. Johns-Manville Co., 100 William street, New York City.

A comparison of the contracts for a single-phase railway equipment which the Washington, Baltimore & Annapolis Railway has just placed with the General Electric Co., with those let by the same corporation some three years ago, but abandoned on account of financial difficulties, shows some changes which are significant. The original specifications called for a trolley potential of 1,000 volts and a frequency of 16 2-3 cycles per second. The present contract calls for a trolley potential of 6,600 volts and a frequency of 25 cycles per second. Instead of a four-motor equipment aggregating 400 horsepower, which would drive the trains at 40 miles per hour on level track, the specifications now require an aggregate of 500 horsepower, which will enable the trains to attain a speed of 60 miles per hour.

TRADE CATALOGUES.

Century-Klein Electric Co.'s New Electrical Supply Catalogue.—This company will issue shortly a very complete electrical trade catalogue. As the supply will be very limited, those desiring copies should send in their requests at once.

Requests will be placed on file in the order received, and distribution made accordingly.

The issue will be ready in about sixty days.

News Notes.

POWER AND LIGHT PLANTS.

Boise, Idaho.—Carroll George Dollman, of Hagerman, reports that plans are being made to erect a power plant at Salmon Falls.

Baker City, Ore.—John Thomson, manager of the Tremont Power Co., states that the plant will be changed from steam to electrical power.

Dawson, Alaska.—The Dawson Electric Light & Power Co. has been taken over by N. A. Fuller and others, who are preparing to furnish electricity in the future from the Coal Creek mines by a transmission line fifty miles in length.

Portland, Ore.—The P. & S. Logging Co. of Portland and Vancouver has just completed arrangements for the erection of a big electric power plant near Kalama, Wash.

Phillipsburg, M.—Efforts are being made by J. T. Baker, of Garnet, and Chester Calhound and O. S. Thorp to lease the electric light plant.

Post Falls, Idaho.—The W. W. P. Co. is perfecting arrangements for an immense steam plant at this place to be located adjacent to its electric power house.

Springdale, Wash.—The new electric lighting plant of J. W. Gillingham is nearly completed and will soon be in operation. The new plant is to be operated by water power.

Echo, Ore.—It is reported that the city council is considering the establishment of a municipal electric light plant, using gasoline engines for motor power.

Hamilton, Mont.—The Anaconda Copper Mining Co. contemplates making extensive improvements in the electric light plant at this place.

Hillyard, Wash.—The Hillyard Water Co. will erect a new power house of concrete blocks on the corner of Twentieth and Martha streets.

Olympia, Wash.—The Lake Chelan Water Power Co., organized under Arizona laws, with $3,000,000 capital, filed articles here. Its objects are to engage in general transportation, irrigation and mercantile business. Incorporators: James McMillan of Minneapolis, president; Junious Bebee of Wakefield, Mass., vice-president; Albert F. Helliwell of Minneapolis, secretary and treasurer; Carrie E. McMillan and Charles F. Linnmayer of Minneapolis. The chief place of business is Phoenix, Ariz. Branch offices are provided for at Chelan, Washington, Boston, Minneapolis and New York.

Roseburg, Ore.—The city council has granted the Willamette Valley Co. a 50-year franchise for a water and electric light plant.

Seattle, Wash.—Will H. Parry states that a contract has been let by the Pasco Power & Irrigation Co. for the immediate installation of a new pumping plant at Five-Mile rapids on the Snake river.

ELECTRIC RAILWAYS.

Lewiston, Idaho.—Work has been resumed on the grading of the Lewiston Southeastern Electric road.

Moscow, Idaho.—A crew of Spokane & Inland surveyors are running a new line toward this place.

Prince Albert, Sask.—The W. S. Weeks Co. has applied for a twenty-year franchise for a street railway. Company will expend $80,000 on plant track and cases within three years.

Seattle, Wash.—The S. E. Co. is double-tracking eleven more blocks of the University line.

Seattle, Wash.—The S. E. Co. is preparing to make application for the use of streets which will extend its car system fifteen miles within the city and will require the construction of twenty-one miles of track; estimated cost, $1,000,000, including equipment.

Spokane, Wash.—The Spokane Interurban Ry. Co., with a capital of $150,000, was incorporated by C. P. Lind, C. W. Ewart, L. R. Hamblen, W. S. Gilbert, and H. L. Bleecker. The line will run between this city and Cheney.

Tacoma, Wash.—Work on the underground crossing with the N. P. at South Tacoma will be commenced this week by the Pacific Traction Co. at a cost of $15,000.

West Seattle, Wash.—This city decided by a vote of 115 for to 13 against, to sell its street car system to the S. E. Co. for $30,000.

The Spokane & Inland Railway Company, controlled by the Inland Empire Electric Railway Company, of which Jay P. Graves of Spokane, is president, has installed a four-train service between Spokane and Waverly, thirty-five miles south of Spokane. The equipment is the latest approved pattern and the roadbed is said to be among the best in the Pacific Northwest.

Progress is being made by the Inland Empire Company's workmen on the big power plant at Nine Mile Bridge, twelve miles northwest of Spokane, where 9,000 horsepower will be developed for use on the Spokane & Inland and the Spokane Traction Company's lines.

Eugene, Ore.—Superintendent Hodgson states that preliminary surveys for the electric road to Springfield have been completed. Three routes are under consideration.

Miles, Wash.—Grading will begin next week for the new line of the Big Bend Traction Co.

Spokane, Wash.—Right of way has been secured and contract let to Grant, Smith & Co. for the extension of the Spokane & Inland Ry. Co. The line will run from Greenacres to Liberty Lake, a distance of two miles.

Tacoma, Wash.—Work has been resumed on the Steilacoom line of the Pacific Traction Co. The bridge over Chambers creek is now being built.

North Yakima, Wash.—Mayor Walter Reed vetoed the franchise of the Yakima Intervalley Traction Co.

Seattle, Wash.—Preparation is being made to file applications for the new franchises which will be asked by the Seattle Electric Co. for extensions covering more than 15 miles of streets. President Furth states that the proposed ordinances will be presented to the council at the meeting October 22d.

Sumas, Wash.—The people of the Sumas, B. C., municipality will hold an election October 20th to vote on the granting of a franchise to the British Columbia Electric Co. for an electric line through the town. The company will also ask the right to build transmission lines for light and power.

TELEPHONES AND TELEGRAPHS.

Bend, Ore.—The Deschutes Tel. Co. has purchased the telephone line between Pineville and O'Neil.

Bellingham, Wash.—Captain Dunson states that a wireless telegraph station will be established on Smith's Island in the near future at a cost of $30,000.

Coeur d'Alene, Idaho—The R. M. Bell Telephone Co. is adding two more direct lines from Spokane to this city and also one more to Sand Point.

Eugene, Ore.—Workmen commenced setting poles in the eastern part of the city preparatory to putting in 25,000 feet more cable.

Kent, Wash.—Farmers in the Sunnyside district will build a telephone line from there to this place.

La Grande, Ore.—Workmen are placing the equipments for telephones on all trains and freight cabooses for the O. R. & N. Railway.

Seattle, Wash.—More than 225 miles of cable, which will be laid by the Burnside to Ketchikan, has arrived and will be loaded on the cable ship as soon as she leaves Moran's ship yards.

Sumas, Wash.—The Postal Telegraph Co. will immediately repair its line between here and Sedro-Woolley.

Walla Walla.—The Pacific States Telephone Company will construct another line to Milton, Ore.

Aberdeen, Wash.—D. C. Simons and associates were granted a franchise for a telephone line on the Wynooche river road.

Aberdeen, Wash.—E. C. Smith states work will begin on the independent telephone system in about 90 days.

Bonners Ferry, Idaho—George W. Andrews, manager of the R. M. Bell Tel. Co., and J. C. McCahn, foreman, are here completing arrangements for putting in the system. The line between here and Colburn will be completed by November 15th.

Centralia, Wash.—Elmer Scherer was granted permission by the county commissioners to construct a telephone line from the Reform school to the Macomber and Urquhart mill.

The Canadian Pacific Railroad has run a special copper wire between Montreal and Winnipeg, a distance of 1,430 miles, touching only Fort William and North Bay, for its telegraphone system, by means of which two messages—one by telephone and the other by telegraph—can be transmitted over the wire at the same time. A number of tests have been made at both Montreal and Winnipeg, where the operators at each end were able to converse with those at the other end, while in the meantime the operators at Fort William were sending a message by telegraph over the wire to Montreal, thus proving the success of the new system. It is claimed this is the greatest distance a human voice has ever been sent over such a circuit, but the Canadian Pacific Railroad officials think the wire will work just as well at a still greater distance. The introduction of a long-distance telephone in connection with a railway opens up great possibilities. It will be a boon to the heads of departments who wish to converse with other departments hundreds of miles away. It will eliminate the long "service" messages which so frequently tie up the wires. The Canadian Pacific Railroad Co. intends to install the system along all its lines as soon as possible.

INCORPORATIONS.

Washington.

Increase of capital stock of the Curran Timber Co., Everett, from $100,000 to $250,000.

Cowlitz Valley Railway & Power Co., Seattle, $5,000,000; C. C. Brown and C. R. Bell.

Protective Mining Co., successor to the Forrest City Mining Co., Seattle, $1,000,000; F. W. Cleveland, W. W. Shenk, Joseph Grimes and J. R. Ritchie.

Clerin-Hamilton Lumber Co., Raymond, $60,000; G. P. Clerin and J. C. Hamilton.

WATER POWER.

The Big Bend Water Power Company of Spokane, has been reorganized, the president being B. F. O'Neill, president of the State Bank of Commerce at Wallace, Idaho, and head of the Idaho Northern Railway Company, the vice-president being J. W. Douglas of New York, and Mrs. A. M. Phillips of Minneapolis, Minn., secretary. The company has a power site twenty-eight miles down the Spokane River, where 30,000 horsepower can be developed. Announcement is made that the company will build from Wallace to Murray, and that the Idaho Northern will eventually be extended westward to Spokane.

TRANSMISSION.

The Washington Water Power Company of Spokane, will reach Palouse, Wash., south of Spokane, in a few days, the wires carrying 60,000 volts, which will be stepped down by transformers to the 2,300 horsepower necessary to fill the Palouse contract. The company has awarded a contract to Moser & Son of Palouse, for a sub-station, where $19,000 worth of machinery will be installed. Palouse is the terminus of the line from Spokane. Pullman, Moscow and other towns south of Spokane, will be supplied from a power plant to be erected on the Snake River near Asotin, Idaho.

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